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BULLETIN
DE LA
**SOCIÉTÉ NEUCHÂTELOISE
DES SCIENCES NATURELLES**

FONDÉE EN 1832

**XIIIe Colloque
Européen d'Arachnologie**

2 - 6 SEPTEMBRE 1991 - NEUCHÂTEL

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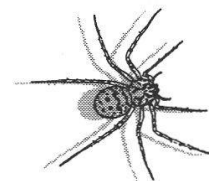
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ainsi que toutes les firmes et tous les commerçants qui ont bien voulu insérer une annonce publicitaire dans notre programme.

Il tient également à exprimer sa plus profonde reconnaissance à toutes les personnes qui ont participé, bénévolement, à l'organisation de cette manifestation: B. Cattin, M. Fürst, I. Geith, N. Hügli, C. Liechti, R. Meier, J. Monney, S. Pearson, P. Pronini, D. Sauser, G. Blandenier. Complètement dévouées aux vœux des 200 personnes (congressistes, accompagnants, commerçants, techniciens, ...) impliquées dans ce colloque, elles n'ont pas hésité à fonctionner comme traductrices, chauffeurs, secrétaires, guides touristiques, hotesses d'accueil, téléphonistes; et tout cela avec sourire et gentillesse. Sans elles, la roue n'aurait pas tourné!

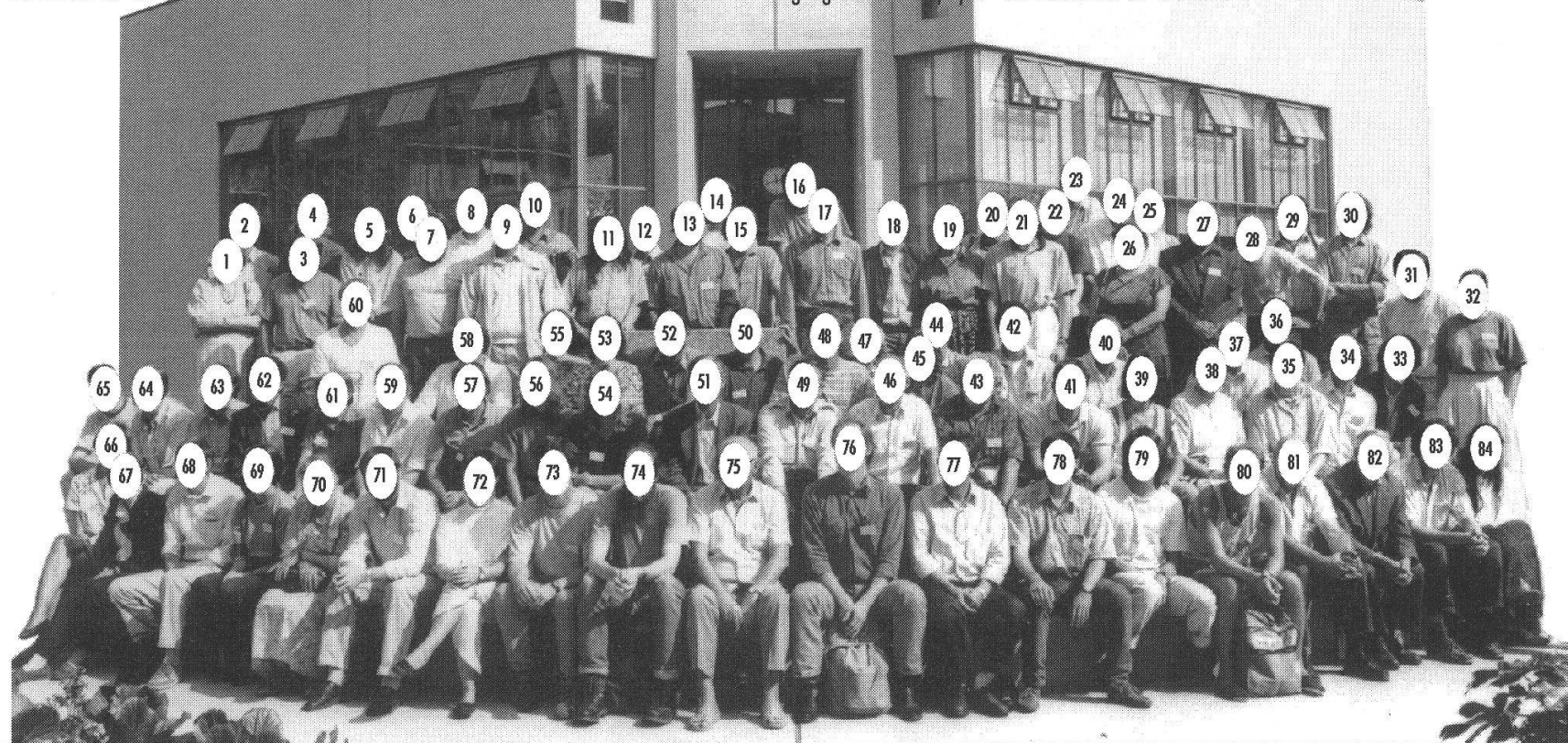
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P R É F A C E

Cette publication réunit les travaux présentés au XIII^e colloque européen d'arachnologie organisé conjointement par la Société européenne d'Arachnologie, l'Institut de zoologie de l'Université de Neuchâtel et le Groupe neuchâtelois d'Arachnologie. Il s'est tenu entre le 2 et le 6 septembre 1991 à l'Aula de la Faculté des lettres de l'Université. Une centaine de scientifiques, en provenance de 15 pays, ont participé intégralement ou partiellement à ce colloque.

Ouverte par une allocution du recteur de l'Université, M. Rémy Scheurer, la manifestation s'est poursuivie par six sessions scientifiques. Les communications et posters présentés ont traité successivement de faunistique et zoogéographie, d'écologie, de bioindication, de physiologie, de reproduction, de biologie des populations et d'éthologie, pour ne citer que les principales facettes de la multidisciplinarité de ce colloque. Tous ces sujets sont d'ailleurs représentés dans les présents comptes-rendus.

En marge de la partie strictement scientifique, diverses activités ont été organisées, dont: une conférence tout-public sur *La peur de la nature* donnée par M. Jean-François Terrasson qui a su tenir les nombreux spectateurs en haleine, une excursion faunistique dans le cirque grandiose du Creux-du-Van, l'Assemblée générale annuelle de la Société Européenne d'Arachnologie. Une réunion des arachnologues suisses a également eu lieu pour discuter du catalogue des araignées de Suisse (Richard Maurer et Ambros Hänggi, 1990) et plus spécialement des suites possibles à donner à cet important travail. Le tout a été ponctué par une allocution du Conseiller d'Etat, M. Jean Cavadini, lors du banquet officiel. C'est à cette occasion aussi, que M. Joachim Haupt (Berlin) a cédé sa place de Président de la Société européenne d'Arachnologie, à M. Pierre-Alain Fürst (Neuchâtel). Une excursion post-colloque d'un jour, nous a emmené au Saut-du Doubs, via le Musée du Château des Monts au-dessus du Locle.

Nous tenons à exprimer notre profonde gratitude à la Société neuchâteloise des Sciences naturelles qui a accepté de publier ces comptes-rendus dans sa revue, selon ses standards qui donnent du corps à l'oeuvre:

35 articles sont rassemblés dans ce volume, parmi les 21 posters et 31 communications ayant été présentés. En plus, 5 notes ou résumés y ont été annexés. La Table ronde sur la bioindication ayant essentiellement joué un rôle de catalyseur pour d'autres discussions à venir, nous n'en publions pas le résumé, ni les interventions dans les présents comptes-rendus.

Nous profitons également de ces quelques lignes pour remercier les scientifiques qui ont accepté d'officier en tant que présidents de session: Mme F. Murphy et Mrs A. Canard, J. Haupt, V. Mahnert, W. Matthey, P. Merret, W. Nentwig, J. Proszynski.

Les congressistes se sont séparés dans la promesse du XIV^e Colloque européen, qui aura lieu en 1993, à Catania en Sicile.

Pierre-Alain Fürst, Gilles Mulhauser, Blaise Mulhauser

Escorpiones y opiliones de la provincia de Córdoba (Argentina): diversidad y zoogeografía

par
Luis Eduardo Acosta

Summary: Scorpions and opilions of the province of Córdoba (Argentina): diversity and zoogeography.

The province of Córdoba, in middle Argentina, comprises three main biogeographical areas: the "Chaco", the "Pampa" and the hilly region. The specific diversity of Scorpiones and Opiliones, as well as their distribution patterns were examined through extensive collections. Both for scorpions and opilions, three well characterized zoogeographical areas can be delimited, roughly concordant to the above cited biogeographical ones: (1) Chacoan area (Sc - *Timogenes elegans*, *T. dorbignyi*, *Brachistosternus ferrugineus*, *Bothriurus* aff. *bonariensis*; Op - *Gnidia holmbergii*). (2) Littoral-pampasic area (Sc - *Bothriurus bonariensis*, *Tityus trivittatus*; Op - *Discocyrtus* (3 spp.), *Holmbergiana weyenberghii*). (3) Hilly area (Sc - *Zabius fuscus*, *Bothriurus* aff. *prospicius*, *Urophonius brachycentrus*, *U. achalensis*; Op - *Pachyloidellus* (3 spp.), *Neopucroliella* (6 spp.), *Ceratontia centralis*). The higher altitudinal environments of the hills can be clearly distinguished as a subarea, for they have endemic species (one scorpion, one opilion), and represent a distribution limit for most species. The hills of Córdoba show relationships with the hilly systems of the province of Buenos Aires (Argentina); the recognition of a "peripampasic track", comprising the two systems, is proposed.

1. INTRODUCCION

La provincia de Córdoba, República Argentina, se sitúa entre 29°26' y 35°01' de latitud sur, y 61°46' y 65°47' de longitud oeste, con una extensión de 165.321 km². La mayor parte de su territorio está ocupada por planicies (llanuras y piedemonte), repre-

sentando el área serrana aproximadamente 1/6 de la superficie total. Córdoba está íntegramente dentro de la zona de clima templado: la temperatura media anual varía entre 19°C en el norte y 10°C en las altas cumbres. Estas últimas reciben la máxima precipitación pluvial (más de 900 mm al año), mientras el área NO, con menos de 400 mm, es la región más seca de la provincia.

Por su ubicación central, Córdoba es sitio de encuentro de faunas (RINGUELET 1961; BUCHER & ABALOS 1979). Desde el oeste llegan formas subandinas, en tanto desde el este y el norte se hace presente una importante fauna chaqueño-subtropical. A ello se suma el carácter particular del área serrana -verdadero centro de diferenciación faunística-, de lo cual resulta una diversidad animal importante. Producto de este aporte mixto, hay en la provincia 17 especies de escorpiones. Para el orden Opiliones, del cual no hay formas subandinas, el número de especies registradas hasta el momento se eleva a 23 -una de ellas es, sin embargo, introducida: *Nelima doriae* (Canestrini) (ACOSTA & COKENDOLPHER 1990)-.

Escorpiones y opiliones tienen un interesante rasgo en común: su valor como indicadores zoogeográficos (en su mayoría son organismos estenoicos y con capacidad limitada de desplazamiento). En razón de ese interés, presento aquí, de modo abreviado, los resultados del relevamiento que realicé de estos dos órdenes en la provincia de Córdoba -parte de mi trabajo de Tesis Doctoral (ACOSTA 1989)-, los cuales espero sirvan de aporte a la comprensión de la aún poco estudiada zoogeografía regional.

Agradezco a la Comisión Organizadora del XIII Coloquio Europeo de Aracnología su invitación a publicar el presente trabajo, y a Fr. K. Rehbinder, del Institut für Zoologie (Mainz) la realización de las ilustraciones.

2. AREAS ESCORPIO Y OPILIOLOGICAS DE CORDOBA

Los escorpiones y opiliones de la provincia pueden reunirse en tres grupos faunísticos, que caracterizan sendos territorios zoogeográficos, en gran parte coincidentes para ambos órdenes. La figura 1 muestra básicamente las áreas escorpiológicas, indicando al mismo tiempo las diferencias con las definidas por la distribución de los opiliones (ver texto explicativo de dicha figura). A su vez, tales territorios muestran mayor congruencia con las regiones fitogeográficas propuestas por LUTI et al. (1979), que con cualquiera de las regiones zoogeográficas publicadas (RINGUELET 1961; BUCHER & ABALOS 1979; MAURY 1979).

2.1 Area chaqueña

La vegetación de esta zona se distingue por su carácter xerofítico, y se compone de un mosaico de bosques, matorrales espinosos, y pastizales. Las Sierras del Norte separan al chaco cordobés en dos sectores, en el NE y el NO de la provincia respectivamente -este último algo más seco y con la influencia de la provincia fitogeográfica del monte. Un amplio ecotono entre el área chaqueña y la pampásica es conocido con el nombre de "espinal".

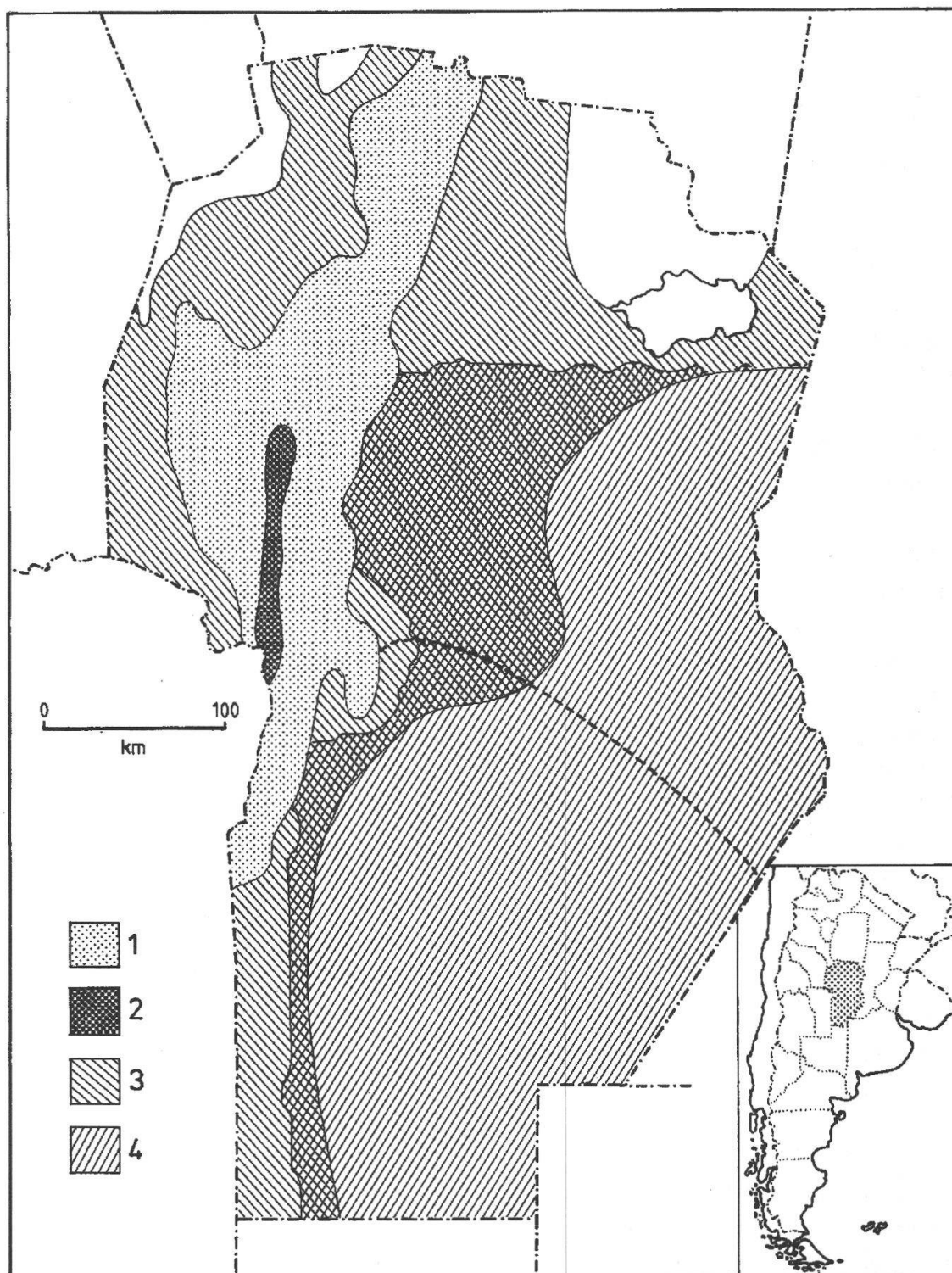


Fig. 1. - Territorios zoogeográficos mencionados en el texto, basados esencialmente en la distribución de escorpiones. 1: Área serrana. 2: Subárea de las "altas cumbres". 3: Área chaqueña. 4: Área litoral-pampásica; el extenso sector cuadrículado representa el ecotono entre las dos últimas. Las áreas opiliológicas son aproximadamente coincidentes, excepto que en el este de las sierras las formas chaqueñas se limitan al sector NE (no existe por tanto el amplio ecotono, ni opiliones chaqueños en el SO provincial), y que en la mitad sur del área 4 -llamada en este caso sólo "área litoral"- no se tienen aún registros de ese orden (en trazo discontinuo, límite meridional de capturas). Los sectores blancos al NO y NE son áreas presumiblemente libres de escorpiones y opiliones. En el recuadro inferior derecho, ubicación de la provincia de Córdoba.

Dos especies de escorpiones son muy frecuentes en ambientes chaqueños, así como en el espinal: *Timogenes elegans* (Mello-Leitão) y *Brachistosternus ferrugineus* (Thorell). Otras formas tienen una distribución más restringida: *Bothriurus* aff. *bonariensis*, sólo en el sector NE; *Tityus confluens* Borelli, en el NO, y *Timogenes dorbignyi* (Guérin), predominantemente en este último. El bosque chaqueño del oeste recibe además el avance de *Brachistosternus pentheri* Mello-Leitão, muy común en el monte, así como dos formas de raro hallazgo: *Vachonia* sp. y *Zabius birabeni* Mello-Leitão. En el chaco del este puede hallarse ocasionalmente *Tityus trivittatus* Kraepelin.

La fauna chaqueña de opiliones es sumamente pobre: el cosmétido *Gnidia holmbergii* (Sörensen), con capturas en los sectores este y oeste, y posiblemente también el palpator *Caiza argentina* Ringuelet, cuya exacta distribución es empero aún mal conocida.

2.2 Area “litoral-pampásica” (escorpiones) o “litoral” (opiliones)

Comprende por un lado la región fitogeográfica pampeana, estepa graminosa extendida primariamente en el SE provincial; la explotación agropecuaria ha desplazado en grandes extensiones al espinal, lo cual parece haber favorecido el avance de formas pampeanas sobre dicho ecotono. Por otro lado, numerosas especies llegan desde el “litoral fluvial” o “mesopotamia argentina” (ríos Paraná y Uruguay), a favor de áreas húmedas como los frecuentes bosquecillos ribereños en ríos y arroyos de la llanura.

Bothriurus bonariensis (Koch) es el escorpión más característico de la estepa pampeana, llegando en Córdoba hasta la base de las sierras; en algunos sectores de espinal, la especie coexiste con formas chaqueñas. En el sur provincial puede colectarse *Bothriurus prospicius* Mello-Leitão, frecuente en la provincia de Buenos Aires. Desde el litoral avanza *Tityus trivittatus*, único escorpión de interés médico y habitante frecuente de áreas urbanas.

Un importante aporte de opiliones proviene del litoral argentino: dos palpatores, *Holmbergiana weyenberghii* (Holmberg) y *Pectenobunus paraguayensis* (Canestrini), un cosmétido, *Metalibitia paraguayensis* (Sörensen), y varios Gonyleptidae, entre ellos tres especies de *Discocyrtus* Holmberg (ACOSTA, Ms.b), *Pygophalangodus gemignanii* Mello-Leitão, y *Pachyloides thorellii* Holmberg. Los opiliones más frecuentes son, en ese orden, *H. weyenberghii* y *Discocyrtus dilatatus* Sörensen.

2.3 Area serrana

La región montañosa de Córdoba -integrante del sistema orográfico de las Sierras Pampeanas- se ubica en el NO de la provincia. La conforman tres cadenas principales, orientadas de norte a sur: Sierras Chicas o cordón oriental (altura máxima, 1950 m), Sierras Grandes o cordón central (2790 m) y Sierras de Pocho o cordón occidental (1650 m); en el sector medio de las Sierras Grandes existen típicas altiplanicies o “pampas”. Las sierras de la vecina provincia de San Luis muestran gran similitud con las de Córdoba, siendo su fauna y flora casi idénticas.

Desde el punto de vista fitogeográfico el área serrana está comprendida en el Distrito Serrano de la Provincia Chaqueña (CABRERA 1976). Las variaciones en altitud deter-

minan la presencia de tres pisos de vegetación (LUTI et al. 1979): entre 500 y 1300 m el "bosque serrano"; entre 1300 y 1600 m el arbustal de altura o "romerillal"; finalmente, desde los 1600 m los "pastizales y bosquesillos de altura". En las Sierras Grandes, este último puede subdividirse en dos subpisos; el superior -desde los 1900 m- es más frío y húmedo, y comprende lo que aquí denomino como las "altas cumbres". Dicho sector alberga endemismos animales y vegetales (entre ellos, un escorpión y un opilión), que definen un área biogeográfica con rasgos propios, y a la cual no tienen acceso la mayoría de los elementos de zonas más bajas -por cierto, casi todos los escorpiones y opiliones serranos habitan sólo el bosque serrano y el romerillal, así como el subpiso inferior de los pastizales de altura.

El escorpión más común en el área es *Zabius fuscus* (Thorell), acentuadamente orófilo; *Bothriurus* aff. *burmeisteri* parece estar igualmente limitado a la región serrana. *Urophonius brachycentrus* (Thorell), *Bothriurus* aff. *prospicius*, y *Bothriurus flavidus* Kraepelin son también especies típicas de las sierras, aunque no exclusivas de ellas. La forma endémica de las altas cumbres es *Urophonius achalensis* Abalos & Hominal; en Pampa de Achala esta especie es simpátrida de *B. flavidus*, único escorpión presente en los tres pisos altitudinales.

Los opiliones más importantes son las tres especies del género *Pachyloidellus* Müller (ACOSTA, Ms.a), así como seis especies de *Neopucroliella* Roewer.

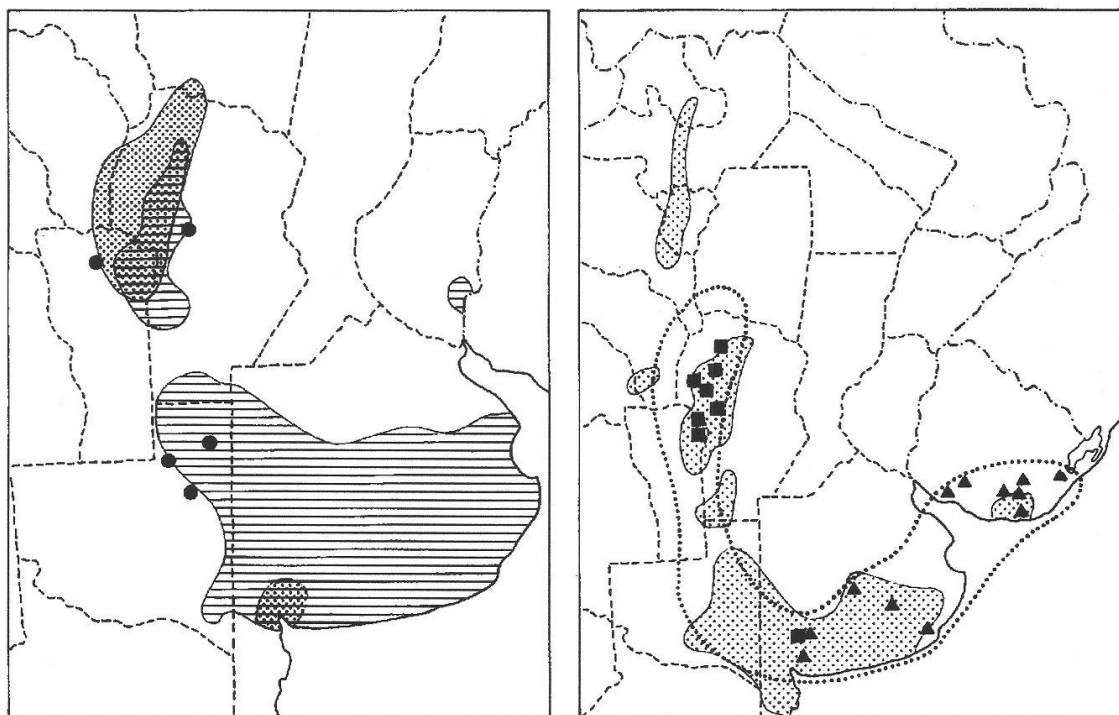


Fig. 2. - Distribución geográfica conocida de taxa relacionados al track peripampásico. Izquierda: *Bothriurus flavidus* (rayado horizontal), género *Neopucroliella* (grisado), género *Riosegundo* (círculos negros). Derecha: *Bothriurus* grupo *prospicius* (grisado), *Ceratomontia centralis* (cuadrados), *Ceratomontia argentina* (triángulos); en línea de puntos, extensión aproximada del track peripampásico.

Pachyloidellus butleri (Thorell) habita ambientes muy similares a *Zabius fuscus*, en tanto *P. fulvigranulatus* (Mello-Leitão) es probablemente endémico de la cima del Cerro Uritorco, en las Sierras Chicas. Una especie innominada de este género es un conspicuo endemismo de las altas cumbres. Por su parte, todas las *Neopucroliella* -de difícil hallazgo, a pesar de su diversidad- parecen excluir en su distribución los ambientes de altura. Por último, el trienoníquido *Ceratomontia centralis* Maury & Roig Alsina es el solo opilión que se halla tanto en los pastizales de altura como en los pisos inferiores.

3. VINCULACIONES DEL AREA SERRANA

La fauna de las sierras de Córdoba y San Luis muestra una manifiesta vinculación con los sistemas orográficos de Tandilia y Ventania, en el sur de la provincia de Buenos Aires. Entre los escorpiones, dos *Bothriurus* ejemplifican tal relación: *B. flavidus* se encuentra en ambos sistemas serranos (extendiendo su rango también fuera de los ambientes montañosos), y algo similar se observa en el grupo *prospicuus*, salvo que una de sus especies llega hasta el noroeste argentino. Dos taxa de opiliones, el género *Neopucroliella* y *Ceratomontia centralis*, repiten en rasgos generales este patrón de distribución. El primero reaparece en Sierra de la Ventana con una especie, *N. mesembriana* Ringuelet (ACOSTA 1990), mientras que en áreas intermedias se distribuye sugestivamente el género próximo *Riosegundo* Canals. En cuanto a *C. centralis*, la misma especie se hace presente en las sierras de Córdoba-San Luis y Ventania; una forma cercana, *C. argentina* Canals, habita los dos sistemas bonaerenses. Todo ello permite reconocer un patrón generalizado de distribución o "track", al que denominaré "peripampásico" (figura 2). En sistemas serranos del sur de Uruguay existe otra especie de *Bothriurus* grupo *prospicuus* (*B. bucherli* San Martín), así como la mencionada *C. argentina*, lo que sugiere una posible extensión del track hasta aquella zona. Este patrón de distribución ha sido citado para otros grupos animales (RINGUELET 1961), lo que estaría indicando una antigua conexión de estas faunas, hoy en mayor parte separadas.

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New data on *Donacosa merlini* (Araneae, Lycosidae), a threatened species?

par

Mark Alderweireldt & Rudy Jocqué

Résumé: De nouvelles données ajoutent à la connaissance de la biologie et de la distribution de *Donacosa merlini* Alderweireldt & Jocqué. Puisque l'habitat spécial de cette espèce est en voie de disparition, elle doit être considérée comme en danger et devrait être mise sur la liste de la Convention de Berne.

Summary: The authors give new data on the biology and distribution of *Donacosa merlini* Alderweireldt & Jocqué. Since its special habitat is disappearing at a high rate, the species must be considered as in danger and should be added to the list of the Berne Convention.

1. INTRODUCTION

Invertebrates have usually played a minor role in nature conservation because they have hardly received any attention in assessment studies in the past. However, it was more recently shown that particular groups are good ecological indicators which can successfully be used in biomonitoring. As a consequence, an increasing number of studies were carried out in this context during the last years. For several reasons, lycosid spiders appear to be good ecological indicators (ALDERWEIRELDT & MAELFAIT 1989). They have been well investigated in western Europe, but indicators for mediterranean ecosystems have rarely been pointed out. However, this seems urgently needed in order to try to protect and manage some, often very valuable and vulnerable, mediterranean habitats in a more efficient way. For this reason we draw the attention to *Donacosa merlini*, which is likely to be a good indicator, due to its specialised habitat

requirements. *Donacosa merlini* was recently discovered and described from southwestern Spain (ALDERWEIRELDT & JOCQUE 1992), more precisely the Coto Doñana area (figure 1). This lycosid lives on coarse sandy soils, which are only slightly compacted, associated with *Pinus pinea* L. woodlands. This kind of pine woodlands still occurs in the coastal areas of southern Portugal, Spain and mediterranean France (POLUNIN & SMYTHIES 1973). The habitat is further characterized by small, open sandy places, devoid of litter. This combination of characters makes the habitat of *D. merlini* rare and is therefore supposed to be restricted to raised beach areas in southwestern Spain and perhaps adjacent Portugal. The spider exhibits a most remarkable sexual dimorphism which is partly related to burrowing behaviour (ALDERWEIRELDT & JOCQUE 1992). The life cycle of *D. merlini* was already described earlier. In this short contribution we give more information on its distribution, its burrow, the striking sexual dimorphism, its feeding ecology, the actual threats of its populations and the possibilities for protection.

2. DISTRIBUTION

Donacosa merlini is so far known from eight localities, all situated in southwestern Spain, more precisely in the Coto Doñana area near Sevilla. They are shown in fig. 1 and can be summarized as follows :

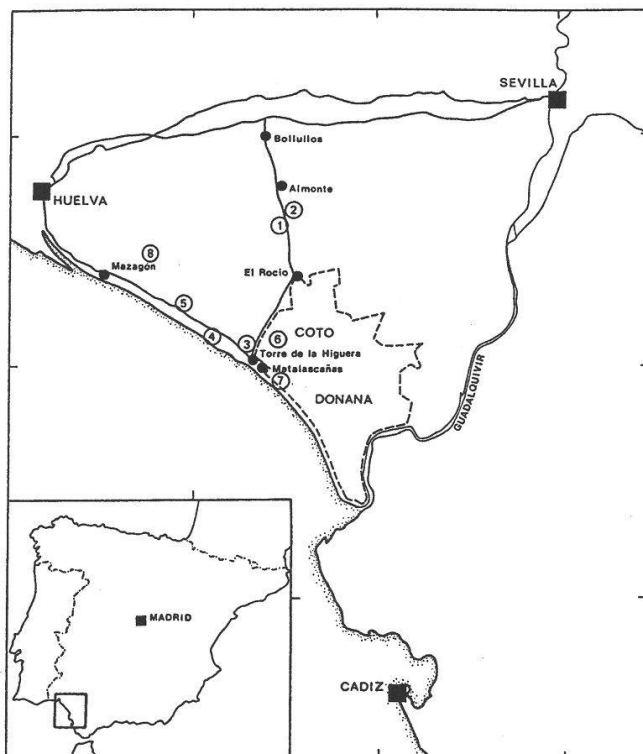


Fig. 1 - Distribution of *Donacosa merlini* in the Coto Doñana area and situation of the Coto Doñana area in southwestern Spain (inset); numbers refer to the distribution data in the text.

1. Almonte, 5 km SW, direction El Rocio;
2. Almonte, 4 km SW, direction El Rocio;
3. Torre de la Higuera, backdunes;
4. backdunes 5 km N of Torre de La Higuera, W of road to Huelva;
5. backdunes 10 km N of Torre de La Higuera, E of road to Huelva;
6. Coto Doñana National Park, control Road, 3.7 km south of main gate;
7. Coto Doñana, western margin just south of Matalascañas;
8. Mazagon, 4 km to the east, N of road to Almonte.

Two of the localities are thus situated within the limits of the Coto Doñana National Park (cf. figure 1).

3. BURROW

A detailed description of the burrow of *D. merlini* was given by ALDERWEIRELDT & JOCQUE (1992). The burrow is on average 19 cm deep with an entrance of 8-12 mm in diameter (subadults and adults). The entrance is always provided with a small turret of silk and plant debris of about 1 cm high. For 34 specimens, the depth of the burrow was measured in the field. Besides, the total body length of the respective owners of the burrows was measured. The results can be summarized as follows (all measurements in mm) :

BODY LENGTH	MEAN DEPTH	BURROW/RANGE DEPTH	BURROW/NUMBER OF OBSERVATIONS
6.0	160.0	(160)	1
11.0	150.0	(150)	1
11.5	175.0	(175)	1
12.0	192.5	(130-240)	12
13.0	205.7	(160-220)	7
13.5	225.0	(220-230)	2
14.0	208.8	(190-225)	4
15.0	235.0	(230-240)	2
16.0	195.0	(195)	1
17.0	175.0	(175)	1
20.0	220.0	(200-240)	2

No clear relationship is found between burrow depth and total body length. This might partly be due to restricted number of observations in some size classes. Moreover, the data within one size class show a high amount of variation. The regression calculated on these data is therefore clearly insignificant ($Y = 0.439X + 14.130$, $R^2 = 0.11$).

4. SEXUAL DIMORPHISM

One of the most striking characteristics of *D. merlini* is its well established sexual dimorphism (cf. detailed description in ALDERWEIRELDT & JOCQUE 1992). Males and females differ in quite some aspects : general habitus and coloration, morphology of the cephalothorax, leg length, to mention only the most important ones. In comparison to other European Lycosidae, this degree of sexual dimorphism appears to be exceptional. As a consequence, some authors did not accept the conspecificity of the male and female described by ALDERWEIRELDT & JOCQUE (ZYUZIN, personal communication). However, recent results of laboratory rearing of *Donacosa merlini* corroborate the conspecificity of the males and females we described. From April 1990 onwards, a female with egg cocoon, brought in from the field by one of us (RJ), was held at room temperature. The resulting pulli were kept in the same conditions. Of this offspring, one male, perfectly matching the original description, reached adulthood after about 19 months which is comparable to the time it takes in field conditions.

This rearing experiment doubtlessly proves the conspecificity of both sexes as described in ALDERWEIRELDT & JOCQUE (1992). Besides this, it became clear that the male is unable to construct a new burrow whereas females and juveniles are well equipped to do so.

5. FEEDING ECOLOGY

From field and laboratory observations, it can be concluded that *Donacosa merlini* is a generalistic predator. Many different kinds of prey items offered were immediately accepted. In field conditions, Myriapoda-Diplopoda, Hymenoptera-Formicidae and Coleoptera (Carabidae and Tenebrionidae) were noted as prey of *D. merlini*. In laboratory conditions, the spiders easily accepted all kinds of Diptera (especially Muscidae and Calliphoridae, but also Drosophilidae for juvenile stages), Dermaptera and Coleoptera. Isopoda were clearly refused, as is the case in many other spider species. Other experiments demonstrated that the spider can survive long periods of food scarcity. Invertebrate predators preying upon *D. merlini* include *Scarites* sp. (Coleoptera, Carabidae).

6. THREATS AND PROTECTION OF DONACOSA MERLINI

As stated earlier, well established populations of *Donacosa merlini* are situated outside as well as inside the National Park of the Coto Doñana in southwestern Spain. The populations outside the officially protected area of the Coto Doñana are threatened by the rapidly increasing human impact, especially urbanisation for touristic and clearing agricultural purposes. The main threats are doubtlessly the plantation of vast areas with *Eucalyptus* in which *D. merlini* does not occur and the increasing

influence of week-end tourism. The declining area of *Pinus pinea* woodland is increasingly visited by picnicking parties which invariably leave ever increasing amounts of refuse. Only very thin populations of *D. merlini* were found in such frequently visited areas that otherwise appeared perfectly suited for this spider. Another threat that might even affect the populations within the boundary of the Coto Doñana National Park, is the enormous expansion of the surrounding settlements which have grown to city-size in the last decennium. Both this and the growing consumption in the agricultural sector, have resulted in an increasing need for water. The groundwater reserves are thus rapidly depleted which will undoubtedly alter the Coto Doñana ecosystem. Therefore the presently existing buffer-zones around Matalascañas are of prime importance to protect the Coto Doñana ecosystem and the populations of *Donacosa merlini* in particular.

Following this argumentation and considering the scarcity of suited habitat, it would appear necessary to include *Donacosa merlini* in the list of endangered species of the Bern convention. This would supply the Spanish Nature Conservancy authorities with a most welcome and helpful tool for protecting the complete area in a more efficient way.

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Spinnentiere und Laufkäfer am Waldrand (Arachnida: Araneae, Opiliones, Pseudoscorpiones; Insecta: Coleoptera: Carabidae)

par

Theo Blick & Peter Bliss

Abstract: The results of pitfall trapping over a whole year, in a transect from inner parts of the forest across the edge to the surrounding land, are presented for Araneae, Opiliones, Pseudoscorpiones and Carabidae. Different distribution patterns are shown for these groups and the species. Spiders have been found with the highest numbers (species and individuals) and with all the different distribution patterns. The most abundant species at the forest border, *Lepthyphantes nitidus* (Araneae, Linyphiidae), is active in the winter.

Résumé: Les résultats d'une année de piégeages au sol, sous la forme d'un transect depuis l'intérieur de la forêt à travers la lisière, sont présentés pour les araignées, opilions, pseudoscorpions et Carabidae. Différents types de distribution sont observés selon les groupes d'invertébrés ainsi que pour les diverses espèces. Les araignées présentent les plus grands nombres d'espèces et d'individus, ainsi que la plus grande variété des types de distribution. L'espèce la plus commune en lisière, *Lepthyphantes nitidus* (Araneae, Linyphiidae), est active en hiver.

1. EINLEITUNG

Im Rahmen des Projektes "Aufbau reichgegliederter Waldränder" (gefördert von der IBFANL [Bundesforschungsanstalt für Naturschutz und Landschaftsökologie], Bonn) werden Neuanpflanzungen reich strukturierter Waldränder begleitend untersucht und diese mit der vorhandenen Waldrandfauna des Untersuchungsgebietes (um Feuchtwangen im westl. Lkr. Ansbach, Mittelfranken, Bayern, BR Deutschland) verglichen.

2. METHODE

Es werden hier Ergebnisse eines Waldrandes am Kronberg vorgestellt, der im ersten Untersuchungsjahr (IV.89 - IV.90) als Vergleichswaldrand erfaßt wurde. Es handelt sich um einen südexponierten Waldrand mit einem Strauchmantel, der bis zu 8 m in den Wald reicht. Die äußeren 50 Meter des Waldes sind sehr stark von Nadelhölzern (Fichte und Kiefer) dominiert. Im äußeren Waldrandbereich ist durch den Strauchmantel und wenige Laubbäume eine Laubstreuauflage vorhanden; ebenso ist dies ab ca. 50 Meter im Wald, bedingt durch einen geringen Buchenanteil, der Fall (vgl. "C" in Tabelle II).

Es befand sich je eine Bodenfallenreihe (Gläser mit Pikrinsäure, Durchmesser 5,5 cm, Fallenwechsel monatlich) mit je 6 Fallen im Waldesinneren (80 m), im inneren Randbereich (8 m), im äußeren Randbereich (1 m) und im vorgelagerten Wiesenstreifen (-3 m) (vgl. Tabellen I & II).

Die Araneae und Carabidae wurden von T. Blick (BLICK 1991), die Opiliones von P. Bliss und die Pseudoscorpiones von D. Schlegel (SCHLEGEL & BLICK 1991) determiniert.

3. RESULTATE

Bei Betrachtung der Summen der einzelnen Tiergruppen (Tabelle I) ergeben sich verschiedene Verteilungsmuster:

- Abnahme vom Waldesinneren zum Umland: Individuen Opiliones und Pseudoscorpiones
- Maximum in den Randbereichen (positiver Randeffect): Arten- und Familienzahlen Araneae, Opiliones und Pseudoscorpiones
- Minimum in den Randbereichen (negativer Randeffect): Individuen Carabidae
- Zunahme vom Waldesinneren zum Umland: Individuen Araneae und Artenzahl Carabidae

Die arten- und individuenreichste Tiergruppe ist deutlich die der Araneae.

Auf Artenbasis zeigen sich vielfältige Verteilungsmuster (s. Tabelle II):

- Araneae (besonders Linyphiidae) gibt es für alle festgestellten Verteilungstypen
- Die Verteilungstypen "C" und "F" sind nur von Spinnen besetzt
- Typische Randarten ("D" und "E") gibt es bei allen bislang untersuchten Tiergruppen
- Arten, die ihren Schwerpunkt im äußeren Randbereich ("E") haben, sind in der Mehrzahl Spinnen (7 Arten, gegenüber 2 Weberknecht- und 1 Laufkäferart)

Tab. I: Summen der Tiergruppen. Sums of the groups. Totaux des groupes.

		Wald	Rand innen	Rand außen	Wiese
		forest	inner border	outer border	meadow
	Gesamtsummen Total sums Sommes totales	forêt	lisière int.	lisière ext.	pré
		80 m	8 m	1 m	3 m
Araneae					
Arten/species/espèces	108	40	54	76	59
adulte Individuen		524	647	1180	1714
Individuen		859	1124	1622	2108
Familien (adult)	15	9	10	14	11
Opiliones					
Arten/species/espèces	12	5	10	10	7
adulte Individuen		161	60	87	24
Individuen		312	171	163	97
Familien (adult)	3	1	3	3	2
Pseudoscorpiones (Neobisiidae)					
Arten/species/espèces	2	1	2	2	1
adulte Individuen		63	21	35	10
Carabidae					
Arten/species/espèces	41	13	18	20	26
adulte Individuen		480	301	208	247

Tab. II. Verteilung der Arten (mindestens 5 adulte Exemplare) auf die 4 Fallenreihen (sortiert nach Fangschwerpunkten). Distribution of the species (at least 5 adult individuals) onto the 4 pitfall rows. Distribution des espèces (au moins 5 individus adultes) sur les 4 séries de pièges.

Art Species Espèce	Familie Family Famille	Wald 80m	Rand innen 8m	Rand aussen 1m	Wiese -3m
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A) Arten mit Schwerpunkt im Waldesinneren/ Species concentrated in the inner forest/ Espèces concentrées à l'intérieur de la forêt

Lepthyphantes minutus	Linyphiidae/Araneae	2			
Centromerus leruthi	Linyphiidae/Araneae	6	3		
Tapinocyba pallens	Linyphiidae/Araneae	12	1	1	
Walckenaeria corniculans	Linyphiidae/Araneae	34	5	4	
Histopona torpida	Agelenidae/Araneae	127	9	13	
Molops elatus	Carabidae/Coleoptera	26		1	
Pterostichus metallicus	Carabidae/Coleoptera	41	9	9	

B) Arten, die in allen Waldbereichen vorkommen/ Species which occur in all forest parts/ Espèces se présentant dans toute partie de la forêt

Harpactea lepida	Dysderidae/Araneae	16	5	7	
Ceratinella brevis	Linyphiidae/Araneae	11	3	6	2
Saariotoa abnormis	Linyphiidae/Araneae	9	4	3	2
Lepthyphantes flavipes	Linyphiidae/Araneae	5	2	4	1
Centromerus pabulator	Linyphiidae/Araneae	5	3	2	
Walckenaeria obtusa	Linyphiidae/Araneae	3	2	2	
Lepthyphantes cristatus	Linyphiidae/Araneae	3	7		1
Robertus lividus	Theridiidae/Araneae	3	6	5	2
Cryphoea silvicola	Agelenidae/Araneae	1	2	2	
Walckenaeria acuminata	Linyphiidae/Araneae	1	3	4	1

Art Species Espèce	Familie Family Famille	Wald 80m	Rand innen 8m	Rand ausen 1m	Wiese -3m
Philodromus collinus	Philodromidae/Araneae	4	1	1	3
Walckenaeria dysderoides	Linyphiidae/Araneae	3	5	8	5
Coelotes terrestris	Agelenidae/Araneae	82	56	92	6
Macrargus rufus	Linyphiidae/Araneae	42	34	16	3
Cicurina cicur	Agelenidae/Araneae	14	16	24	2
Lepthyphantes pallidus	Linyphiidae/Araneae	12	16	27	2
Centromerus sylvaticus	Linyphiidae/Araneae	12	35	55	9
Hahnina pusilla	Hahniniidae/Araneae	21	18	65	8
Diplocephalus latifrons	Linyphiidae/Araneae	12	37	82	8
Lophopilio palpalis	Phalangiidae/Opiliones	97	24	24	
Oligolophus tridens	Phalangiidae/Opiliones	41	19	31	
Lacinius ephippiatus	Phalangiidae/Opiliones	13	6	6	
Mitopus morio	Phalangiidae/Opiliones	6	6	2	
Neobisium carcinoides	Neobisiidae/Pseudoscorpiones	63	18	33	10
Pterostichus oblongopunctatus	Carabidae/Coleoptera	48	18	8	1
Abax ater	Carabidae/Coleoptera	257	122	42	3
Abax parallelus	Carabidae/Coleoptera	11	12	6	
Carabus auronitens	Carabidae/Coleoptera	21	27	10	
Carabus nemoralis	Carabidae/Coleoptera	24	31	12	2
Carabus problematicus	Carabidae/Coleoptera	42	51	51	

C) Arten mit Schwerpunkten im Waldesinneren und am äußeren Rand (Laubstreu)/ Species concentrated in the inner forest and the outer border (leaf litter)/ Espèces concentrées à l'intérieur de la forêt et à la marge extérieure (litière de feuilles)

Microneta viaria	Linyphiidae/Araneae	7	1	6	
Diplocephalus picinus	Linyphiidae/Araneae	23		21	

Art Species Espèce	Familie Family Familie	Wald 80m	Rand innen 8m	Rand aussen 1m	Wiese -3m
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D) Arten mit Schwerpunkt in beiden Waldrandbereichen/ Species concentrated in both parts of the forest border/ Espèces concentrées sur les deux cotés de la lisière

Walckenaeria atrotibialis	Linyphiidae/Araneae	2	12	4	
Dicymbium tibiale	Linyphiidae/Araneae		12	3	1
Lepthyphantes tenebricola	Linyphiidae/Araneae	3	38	31	
Meioneta saxatilis	Linyphiidae/Araneae		8	9	
Lepthyphantes mansuetus	Linyphiidae/Araneae		19	97	1
Walckenaeria cucullata	Linyphiidae/Araneae	1	9	25	
Bathyphantes parvulus	Linyphiidae/Araneae		9	40	
Neobisium sylvaticum	Neobisiidae/Pseudoscorpiones		3		
Notiophilus biguttatus	Carabidae/Coleoptera		6	7	
Carabus glabratus	Carabidae/Coleoptera	2	5	9	
Molops piceus	Carabidae/Coleoptera	4	7	12	

E) Arten mit Schwerpunkt im äußeren Waldrandereich/ Species concentrated in the outer border of the forest/ Espèces concentrées à la lisière extérieure

Maso sundevalli	Linyphiidae/Araneae		5	10	1
Oxyptila praticola	Thomisidae/Araneae		4	20	
Lepthyphantes nitidus	Linyphiidae/Araneae		3	51	
Ceratinella scabrosa	Linyphiidae/Araneae		1	4	1
Lepthyphantes nodifer	Linyphiidae/Araneae		1	6	
Abacoproeces saltuum	Linyphiidae/Araneae			9	
Agroeca brunnea	Liocranidae/Araneae			6	
Anelasmacephalus cambridgei	Trogulidae/Opiliones		2	7	
Mitostoma chrysomelas	Nemstomatidae/Opiliones		2	11	2
Platynus assimilis	Carabidae/Coleoptera	1	2	26	2

Art Species Espèce	Familie Family Famille	Wald 80m	Rand innen 8m	Rand aussen 1m	Wiese -3m
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**F) Arten, die vom Wald ins Umland ausstrahlen/ Species of the forest which influence the open land fauna/
Espèces de la forêt qui influencent la faune environnante**

Micrargus herbigradus	Linyphiidae/Araneae	27	152	119	40
Diplostyla concolor	Linyphiidae/Araneae	2	21	89	51
Trochosa terricola	Lycosidae/Araneae	1	31	33	29
Pardosa lugubris [s.str.]	Lycosidae/Araneae		28	94	73

**G) Arten, die vom Umland in den Wald einstrahlen/ Species of the open land which influence the forest fauna/
Espèces du pré environnant qui influencent la faune de la forêt**

Lepthyphantes tenuis	Linyphiidae/Araneae		3	20	16
Porrhomma microphthalmum	Linyphiidae/Araneae	4	2	10	84
Alopecosa pulverulenta	Lycosidae/Araneae		3		11
Micaria pulicaria	Gnaphosidae/Araneae			3	4
Dicymbium nigrum brevisetosum	Linyphiidae/Araneae			5	11
Walckenaeria nudipalpis	Linyphiidae/Araneae			6	42
Phalangium opilio	Phalangidae/Opiliones			5	16
Carabus granulatus	Carabidae/Coleoptera	2	4	6	34
Pterostichus melanarius	Carabidae/Coleoptera		2	2	31
Poecilus cupreus	Carabidae/Coleoptera		1	2	43

H) Offenlandarten/ Species of the open lands/ Espèces des prés et champs

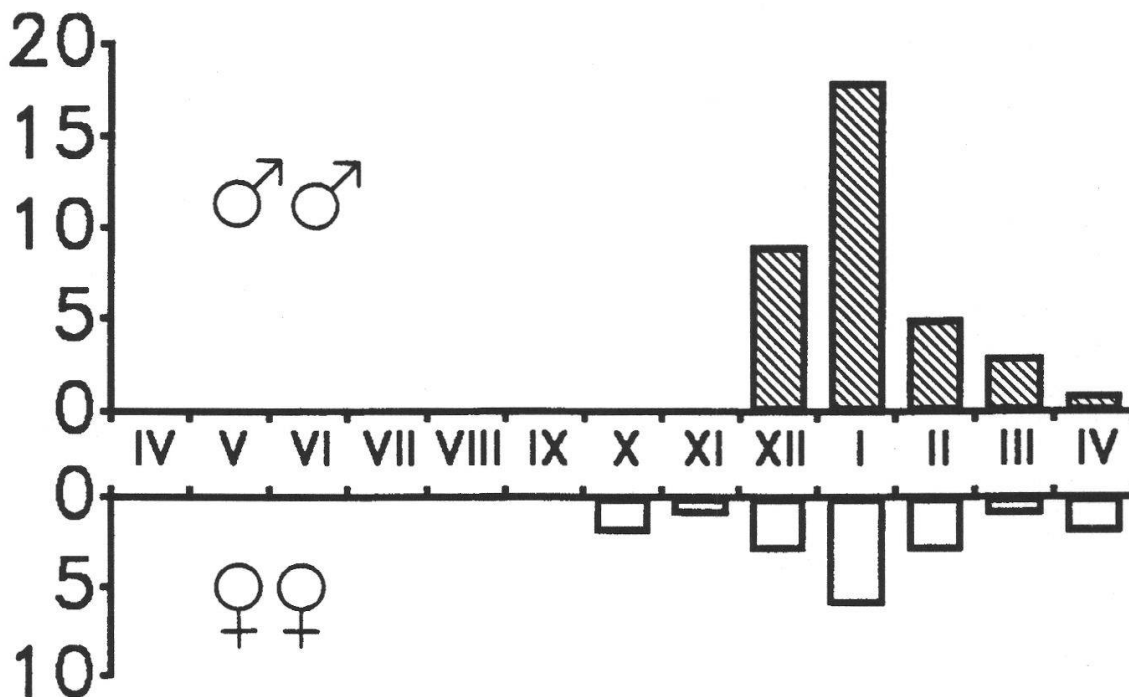
Micrargus subaequalis	Linyphiidae/Araneae			1	5
Zelotes pusillus	Gnaphosidae/Araneae				8
Walckenaeria vigilax	Linyphiidae/Araneae				10

Art Species Espèce	Familie Family Famille	Wald 80m	Rand innen 8m	Rand aussen 1m	Wiese -3m
Phrurolithus festivus	Liocranidae/Araneae			1	10
Pardosa palustris	Lycosidae/Araneae			2	29
Pardosa pullata	Lycosidae/Araneae			1	32
Bathypantes gracilis	Linyphiidae/Araneae			1	46
Centromerita bicolor	Linyphiidae/Araneae			1	53
Araeoncus humilis	Linyphiidae/Araneae			1	89
Meioneta rurestris	Linyphiidae/Araneae				91
Pachygnatha degeeri	Tetragnathidae/Araneae			1	160
Erigone atra	Linyphiidae/Araneae				213
Erigone dentipalpis	Linyphiidae/Araneae				260
Oedothorax apicatus	Linyphiidae/Araneae				263
Calathus fuscipes	Carabidae/Coleoptera				5
Clivina fossor	Carabidae/Coleoptera				5
Bembidion properans	Carabidae/Coleoptera				8
Nebria brevicollis	Carabidae/Coleoptera				14
Platynus dorsalis	Carabidae/Coleoptera				15
Bembidion lunulatum	Carabidae/Coleoptera				26
Amara aenea	Carabidae/Coleoptera				34

Die häufigste Art des Types "E" (s. Tabelle II) *Lepthyphantes nitidus* (Thorell, 1875) ist winteraktiv (Abbildung 1). Dies gilt auch für einige andere Spinnen- und Pseudoskorpionarten (z.B. *Macrargus rufus* "B", *Cicurina cicur* "B", *Centromerus sylvaticus* "B", *Neobisium carcinoides* "B", *Lepthyphantes mansuetus* "D", *Neobisium sylvaticum* "D", *Walckenaeria nudipalpis* "G", *Centromerita bicolor* "H").

L. nitidus wurde bislang nur selten gefunden (z.B. WIEHLE 1963; MORITZ 1973; allerdings mehrere Funde in Bayern: s. BLICK & SCHEIDLER 1991; zahlreiche Exemplare meldet auch MILLER (1967) im Beifang von *Zelotes aurantiacus*).

Abb. 1: Phänologie von *Lepthyphantes nitidus* (absolute Fangzahlen)



4. SCHLUßFOLGERUNGEN

Da Spinnen vielfältige und auch spezifische Verteilungsmuster aufweisen und am arten- und individuenreichsten vertreten sind, ist zu fordern, daß bei Bodenfallenfängen auf jeden Fall die Spinnen zu bestimmen sind.

Es sollten möglichst viele weitere Tiergruppen determiniert werden, da sie als Beifänge mit erfaßt werden und weitere Informationen bringen, wie dies die Carabidae, Opiliones und Pseudoscorpiones zeigen [in Bearbeitung sind: Staphylinidae, übrige Coleoptera, Formicidae, Rhynchota, Myriapoda, Isopoda].

Ganzjahresfänge sind phänologischen Teilaspekten der Fauna vorzuziehen.

Danksagung: Ich danke Frau Sabine Scherer und Frau Carola Heibach (beide Hummeltal) für die Hilfe bei den Fremdsprachen.

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Neue Funde von *Astrobunus laevipes* (Arachnida, Opiliones, Phalangiidae)

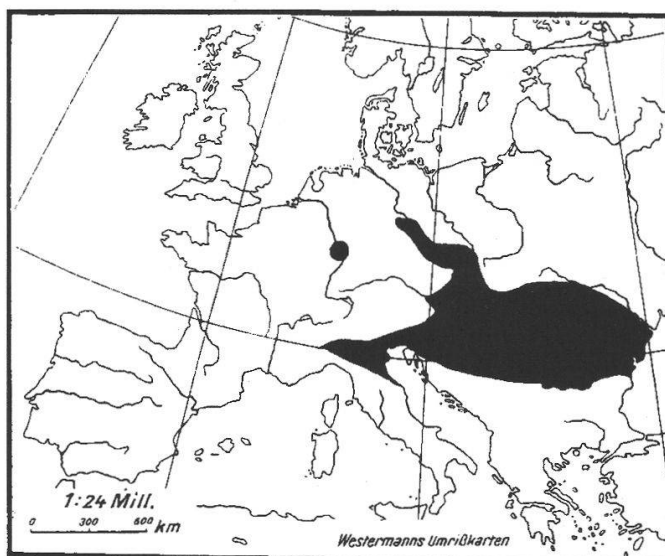
par
Peter Bliss

Summary: New records of *Astrobunus laevipes* (Arachnida, Opiliones, Phalangiidae) In Southeast Germany the records of *A. laevipes* have accumulated during the last few years. In this area the thermophilous harvestman species occure in and around the valleys of the great river systems with partially high activity dominances. This paper names 15 localities in "Sachsen" and "Sachsen-Anhalt". Further faunistic-ecological studies are necessary to describe the areal more precisely. In Germany *A. laevipes* is not endangered from dying out. The expanding process even seems to go on.

1. EINLEITUNG

Der Weberknecht *Astro-
bunus laevipes* (Canestrini,
1872) ist südosteuropäisch ver-
breitet. Westliche Arealaus-
läufer erreichen die Po-Ebene,
das Donautal und im Norden
den mitteldeutschen Raum
(Abbildung 1, nach MARTENS
1978, p. 383-385).

Fig. 1 -Areal von *Astrobunus laevipes*,
nach MARTENS (1978), verändert.



Schon seit längerem ist ein weit westlich vorgeschobenes und isoliertes (?) Vorkommen¹⁾ im Stadtgebiet von Mainz bekannt, dessen Bestand allerdings gefährdet zu sein scheint (MARTENS 1977, 1984).

In Mitteldeutschland mehren sich Nachweise im Elbtal und in den Landschaften der unteren Saale und Mulde. Um einen genaueren Einblick in das Verbreitungsmuster zu bekommen, werden im folgenden neue Funde aus Deutschland mitgeteilt. Herrn Dr. Heinz (Dresden), der seine Funde zur Verfügung stellte, sei gedankt.

2. VERBREITUNGSMUSTER IM OSTEN DEUTSCHLANDS

Der nach Nordwesten ragende Arealausläufer (Abbildung 1) erreicht Deutschland im Dresdener Raum, setzt sich entlang des Elbtales bis Torgau fort, durchzieht die Dübener Heide, erstreckt sich im Westen bis in das Saaletal (Hercynisches Trockengebiet) und findet mit Vorkommen an der Mulde (Eilenburg, Wurzen) wieder Anschluss an das Elbegebiet. Bekannt sind 15 Fundpunkte, die sich auf die beiden Bundesländer Sachsen und Sachsen-Anhalt verteilen. Damit verschiebt sich die Grenze am nördlichen Ende des Arealfingers weiter nach Nordwest und West (Abbildung 2).

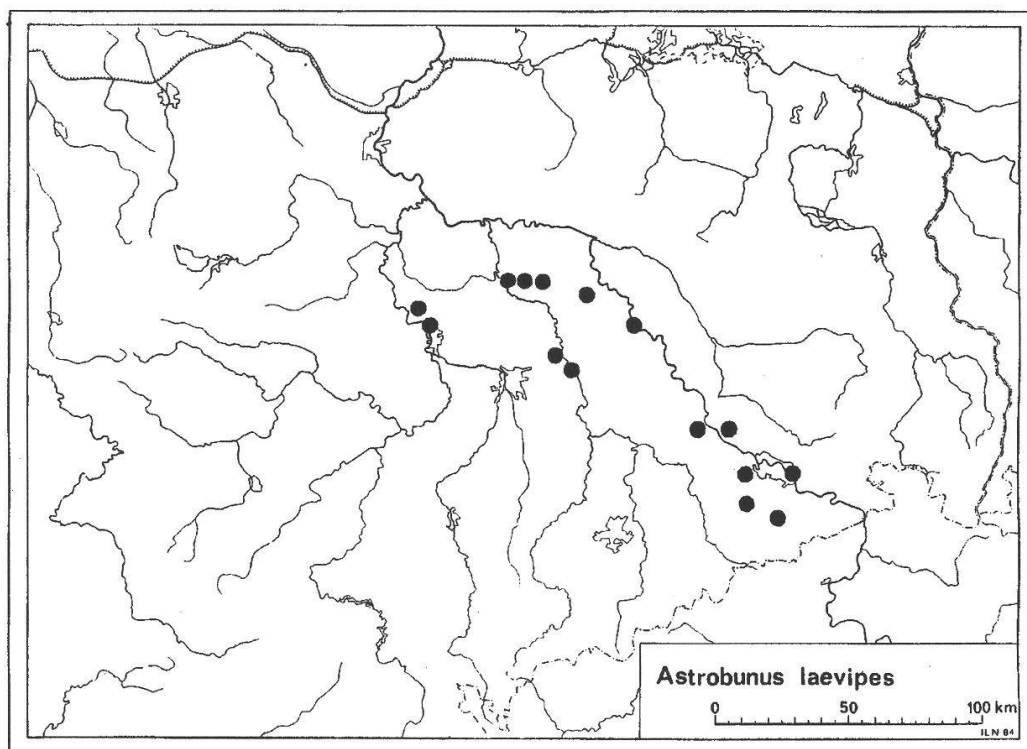


Fig. 2 - Verbreitung von *Astrobunus laevipes* im Osten Deutschlands (Bundesländer Sachsen und Sachsen-Anhalt).

1) H. RAUSCH gibt die Art (ohne Daten) für Baden-Württemberg an (in litt. an T. BLICK, 7.1.1991: "Weberknechte Baden-Württembergs, vorläufiger Entwurf").

Im folgenden werden sämtliche ostdeutschen Funddaten – geordnet nach Bundesländern – aufgelistet. (Alle Nachweise mit Bodenfallen.)

Abk.: BF: Bodenfalle(n) – FND: Flächennaturdenkmal – F. T.: F. TIETZE – H. H.: H. HIEBSCH – H. S.: H. SCHIEMENZ – Kr.: Kreis – MTB: Messtischblatt-Quadrant – MTD: Museum Tierkunde Dresden – ND: Naturdenkmal – NSG: Naturschutzgebiet – UF: Untersuchungsfläche(n) – ZIH: Zoologisches Institut Universität Halle.

Sachsen-Anhalt

Dübener Heide, Kr. Bitterfeld, MTB 4340–1/2 & 4341–1, 90 m NN, Transekt Rodorf bis Reinharz, 7 stark immissionsgeschädigte 25–60 jährige Kiefernforste (Schadzone I), je 8 BF, III–XI 1978 91 ♂ 58 ♀, V–XI 1979 36 ♂ 23 ♀, leg. & coll. P. B., BLISS (1980), BLISS & TIETZE (1984). – NSG "Porphyrlandschaft bei Gimritz", Saalkreis, MTB 4437–1, 140–160 m NN, V–XII 1987, Trockenrasen auf Porphy (3 UF, 15 BF) 25 ♂ 23 ♀, Übergangszone Trockenrasen–Acker (4 UF, 20 BF) 167 ♂ 107 ♀ 16 juv., Acker (2 UF, 10 BF) 8 ♂ 9 ♀ 1 juv., leg. P. SCHNITTER, coll. P. B., SCHNITTER (1991), BLISS (1991a). – Sennewitz, Saalkreis, MTB 4437–4, 93 m NN, 40 jähriger Pappelforst, V–XI 1986 295 ♂ 216 ♀ 9 juv., IV–XI 1987 138 ♂ 130 ♀ 2 juv., coll. P. B., LANG (1989), BLISS (1991b).

Sachsen

Freital-Zauckerode, MTB 4947–4, Ziegeleigelände (Lehmgrube), VIII 1971 1 ♀, leg. NIGRINI, coll. H. H. – FND "Götzenbusch", Kr. Freital, MTB 5047–4, 360 m NN, Heidelbeer-Kiefernwald: VI 1973 1 ♀, Kiefern-Birkenwald: X 1973 1 ♀, Feldrand: X 1974 1 ♂ 1 ♀, Quellsumpf am Sandsteinrücken (wechsel-feuchte Pfeifengras- wiese), X 1974 7 ♂ 21 ♀, leg. E. RÜGER, coll. MTD. – Dresden (HERBST 1799: *Opilio spinosus*; zit. n. MARTENS 1978, p. 384). – NSG "Pillnitzer Elbinsel" (Dresden), Südspitze, MTB 4949–3, 113 m NN, Schotterflur: IX 1955 4 ♂ 1 ♀ leg. H. H., Auwald: VIII 1977 3 ♂ 4 ♀ leg. A. MEUSEL, coll. MTD. – Schlottwitz, ND "Hohler Stein", Kr. Dippoldiswalde, MTB 5148–2, 300–340 m NN, Rotschwingelwiese (wär-meliebende Buschsteppenelemente), VIII 1964 3 ♀, X 1964 6 juv., leg. H. S., coll. MTD, MARTENS (1978). – Prositz, ND "Ketzerbachtal", Kr. Meien, MTB 4846–1, 125–135 m NN, subkontinentaler Blauschwingelrasen, V 1965 1 ♂, X 1965 1 ♀, leg. H. S., det. H. H., coll. MTD. – NSG "Ziegenbusch", Kr. Meien, MTB 4847–1, 180 m NN, Obstplantage (Trockenrasen): X 1979 9 ♂ 3 ♀ XII 1979 3 ♂ 3 ♀, elsbeer-reicher Traubeneichen-Hainbuchenwald (Oberhang): X 1979 1 ♂ leg. HANDMANN, det. H. H., coll. MTD. – Kunzwerda (Elbaue), Kr. Torgau, MTB 4444–3, 81 m NN, Glatthaferwiese, X 1964 1 ♂, leg. F. T., coll. MTD, MARTENS (1978). – Falkenberg, Kr. Torgau, MTB 4342–4, 110–120 m NN, Silbergrasflur, VI–X 1966 1 ♂ 7 ♀ VIII–XI 1967 4 ♂ 2 ♀, leg. F.T., coll. ZIH. – FND "Wachtelberg", Kr. Wurzen, MTB 4642–1, 148 m NN, Südhang, Eichen-Birken-Kiefernwald (wärmegetönt): III–XII 1983 5 ♀ IV 1984 1 ♂ VII 1984 1 ♂ VIII 1984 1 ♂ 2 ♀ X 1984 1 ♂ 3 ♀ XI 1984 3 ♀, leg. W. ZEISIG, det. H. H., coll. MTD. – Wölpern, Kr. Eilenburg, NSG "Torfwiesen", MTB 4541–4, 110–120 m NN, Trockenrasen, VIII 1984 1 ♂, leg. K. HANDKE, coll. H. H.

3. DISKUSSION

Die Reihe der neuen Fundorte belegt, dass *A. laevipes* mindestens in Sachsen und Sachsen-Anhalt weiter verbreitet ist und in günstigen Habitaten häufiger auftritt, als bisher angenommen wurde. Dennoch kann die Abgrenzung des Arealverlaufs wohl noch nicht befriedigen. Unsicherheiten in der Beurteilung sind schon deshalb Beachtung fand. Entsprechend vorsichtig ist daher auch die Isolation der Mainzer Population zu werten. Auch der Gefährdungsgrad der Art ist neu zu überdenken; in einer gesamtdeutschen Roten Liste jedenfalls kann sie nicht in der Kategorie "Vom Aussterben bedroht" (MARTENS 1984) verbleiben.

Offensichtlich sind die Täler der grossen Flusssysteme postglaziale Ausbreitungskorridore für die thermophile Art. "Möglicherweise ist das heutige Areal erst durch rezente Waldverminderung bzw. -auflockerung zustande gekommen" (MARTENS 1978, p. 385). Um aufklären zu können, ob der Ausbreitungsprozess anhält oder gar beschleunigt abläuft, bedarf es einer Intensivierung der faunistisch-ökologischen Arbeit. Der Verf. nimmt deshalb Weberknechtmaterial (Bodenfallen-Beifänge, gezielte Aufsammlungen) gern zur Determination entgegen.

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The injection of venom by a spider (*Cupiennius salei*, Ctenidae) and the weight of an insect prey (*Acheta domesticus*, Gryllidae)

par
Jean-Luc Boevé

Summary: A series of prey items of a given weight were offered to a spider. They were obligatory removed 1 min after the beginning of the attack, and their state noted afterwards. Venom is injected in small as well as in large prey. The prey had 37 to 520 % of the spider weight. The mortality rate of the prey is negatively and linearly correlated with their weight. When a prey weighs about 30 mg or more, the spider (15 mg) injects almost all its venom in the first one of the successive prey items. With smaller prey, the venom glands are gradually emptied during the successive bites.

1. INTRODUCTION

The starvation level of a spider, the relative sizes of spider and prey, and the palatability of the prey are important parameters determining if a spider will attack a prey and if the spider will be successful (NAKAMURA 1987; NENTWIG 1987). Even when a spider subdues a prey, we do not know how much venom is injected and which conditions influence the injection. It may be of prime importance for the spider to modulate, for example, quantity of venom injected and injection rapidity, in function of eco-ethological parameters. In this paper, I answer one main question. Which influence has the prey size on the amount of venom injected?

2. MATERIAL AND METHODS

2.1 Spiders

From a laboratory rearing, neonate spiders of *Cupiennius salei* Keyserling were kept individually in polystyrene boxes (Ø5 X 8 cm) closed by a foam-rubber plug. A bottom of plaster, 2 cm thick, was humidified weekly. The spiders were fed weekly with about ten young *Acheta domesticus* (individual weight of about 1 mg). This cricket species was also used in the bio-assays.

All spiders used in the bio-assays were of instar IV (prosoma length: 2.2-2.5 mm) which lasts 3-4 weeks. When a spider was of this instar for at most one week, it was starved for 2 weeks. It was then used in a bio-assay only when weighing 10.0-20.0 mg.

2.2 Bio-assay

A prey of known weight was placed in the polystyrene box and remained there for a maximum of 10 min. When the prey was caught by the spider, I removed the prey exactly 1 min after the beginning of the attack. The prey was removed by handling the spider with forceps until it released it, which took not more than 10 sec. A second prey item was placed in the box of the spider, 10 min after the deposit of the first one. When this one was also caught, it was removed in the same way, and so on. A maximum of 12 prey items were successively offered per spider, excepted for prey of more than 30.0 mg (see below); from them a maximum of 3 individuals were offered. When a prey was not attacked during the 10 min, the bio-assay was finished for the spider which was never used again.

Prey of the following weight categories were used: 5.0-5.9, 7.0-7.9, 9.0-9.9, 11.0-11.9, 13.0-13.9, 15.0-15.9, 17.0-17.9, 19.0-19.9, 23.0-24.9, 29.0-30.9, 35.0-36.9, 41.0-42.9, 47.0-48.9, 58.0-61.9, and 76.0-79.9 mg. Throughout the text, each category will be designated by its central value. Each spider received prey items of one category. The number of spiders which attacked at least one prey was 24 for those receiving 5.5 and 7.5 mg prey items, and 12 for all others.

In order to compare the effect of the venom with the mechanical effect of the bite onto the prey, the venom glands of spiders were emptied a day before the experiment. By electrical stimulations (9 V) onto the chelicerae, venom droplets appeared, and were removed with filter paper. 12 spiders were tested with 7.5 mg prey items and 12 spiders with 15.5 mg prey items (maximum: 3 per spider).

Venom could be injected during the removal of a prey from the spider. The influence of this possible artifact was assessed. After a 1 min bite, spider and prey were placed during 5 sec under vapors of ether. The prey was then easily removed since the spider was partially anesthetized. This method was not used more generally in the bio-assays, the repeated use of the solvent being toxic for the spider. Prey kept for 5 sec under the vapors were intoxicated only for a short time. 12 spiders were tested with 15.5 mg prey items.

2.3 States of the prey

Each bitten prey item was kept in a humid Petri dish. One hour and 24 h after the experiment, it was gently handled with forceps: it was possibly placed on its back, thorax and abdomen were touched, the cerci pinched. The prey, observed under the microscope, was then in one of the following seven states: “normal” (i.e. normal reactions), “normal-abnormal” (walk normally but rarely jump in order to run away), “abnormal” (walk abnormally), “abnormal-immobilized” (able to turn over with great difficulty when placed on its back), “immobilized” (not able to turn over, but carry out rapid movements of at least one part of the body), “immobilized-dead” (carry out very slow movements of one part of the body), “dead” (absolutely motionless).

3. RESULTS AND DISCUSSION

3.1 State of the prey 1 h and 24 h after the bite of a spider

Almost all 5.5 mg prey items are dead 24 h after the experiment. Most prey items weighing at least 7.5 mg, and which are “abnormal-immobilized” to “normal” 1 h after the experiment, are in a same or a better state 24 h after the experiment (figure 1).

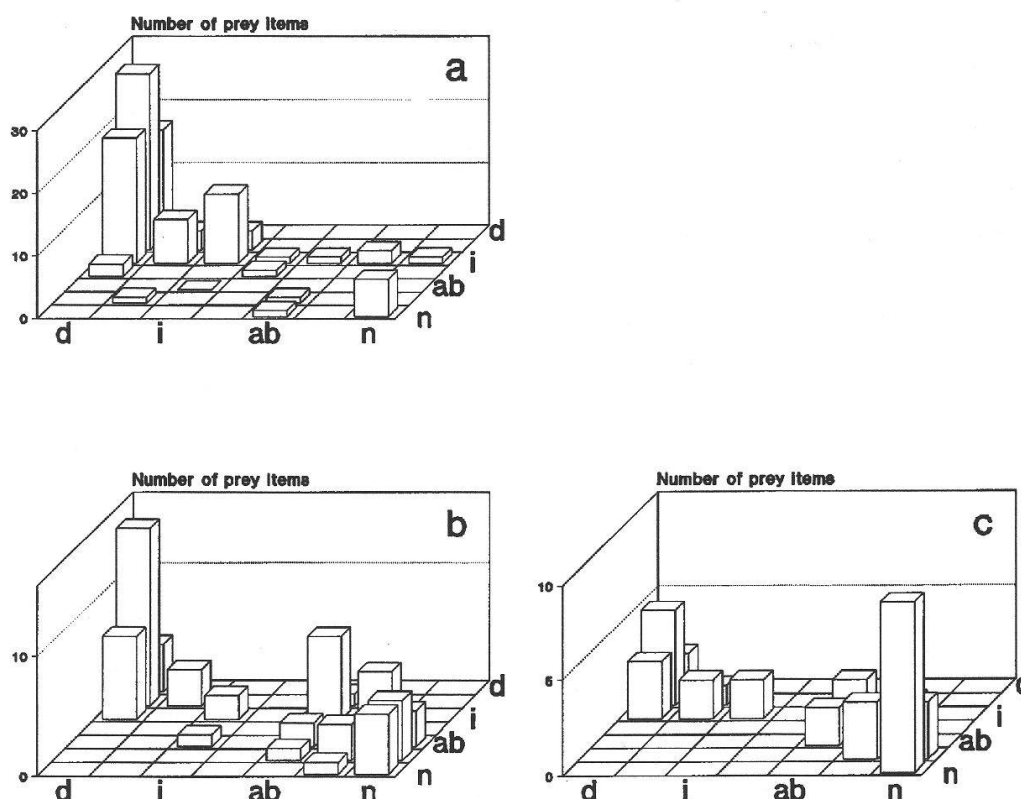


Fig. 1. - Distribution of the prey in function of their state 1h (Z axis) and 24h (X axis) after the bite of a spider. The states of the prey (n) “normal”, (ab) “abnormal”, (i) “immobilized”, (d) “dead”, and the 3 intermediate ones are described in the text (see 2.3.). Prey weight categories of (a) 7.5 mg, (b) 15.5 mg, and (c) 30.0 mg (n= 116, 65, and 35 respectively).

Thus these prey are able to recover. In contrast, most prey first “immobilized” are later either in the same state, or “abnormal” to “normal”, or “dead”. Finally, almost all “immobilized-dead” individuals die afterwards. Thus, it seems likely to consider three groups: “abnormal-immobilized” to “normal”, “immobilized”, and “immobilized-dead”+“dead” prey. Throughout the text, these categories will be designated by normal, immobilized, and dead, respectively, and will be given for the results 24 h after the experiment. Prey weighing at least 30.0 mg are either normal or immobilized+dead (figure 1c). Thus, the prey state is generally not highly different between 1 h and 24 h after the spider bite. Such a temporal stability is also found in several insect species injected with pure venom of *C. salei* (FRIEDEL & NENTWIG 1989).

3.2 The effect of the venom and the mechanical effect of the bite

The number of prey alive (i.e. being immobilized or normal) is high when they were attacked by a spider with emptied venom glands (8 of the 12 prey items weighing 7.5 mg survived, 11 of those weighing 15.5 mg; first prey attacked by the spider) and is significantly lower when attacked by a spider with venom ($P \leq 0.001$ each time for both weight categories, Fisher exact probability test; see also table 1). For the second and third prey attacked, significant differences are achieved with 7.5 mg prey ($P < 0.05$ two times), but not with 15.5 mg prey ($P > 0.05$ two times, considering the relatively high survival rate, even when the prey are bitten by spiders with venom). These results suggest that in the bio-assays, mortality is principally due to the venom, and not to the mechanical effect of the bite.

The 15.5 mg prey items removed under ether vapors, in comparison to those removed with forceps, have a similar number of dead and of immobilized+normal prey ($P > 0.05$ three times, i.e. with the first, second, and third prey attacked, Fisher exact probability test). Thus, the spider does not seem to inject venom when handled with forceps.

3.3 State of the successively attacked prey and prey size

The first attacked prey items (see p1 in table 1) are more frequently dead than alive (immobilized+normal) when they weigh 7.5 mg. When the first attacked prey is compared to the further ones, it is not before the seventh prey item (p7) that the numbers of dead and of alive individuals are significantly different ($P < 0.05$, Fisher exact probability test). Differences are always significant ($P < 0.05$; table 1) when the first prey item is compared with the fifth one (weight categories of 9.5 and 13.5 mg), the fourth one (15.5 mg), and the third or second one (17.5 to 42.0 mg). The higher mortality rates of the first prey may be explained in two ways. 1) The venom glands are gradually emptied during the successive bites and the last prey items receive no venom. 2) Venom glands are never totally emptied during the bio-assay, because the spider “learns” to inject in the last prey items a smaller amount of venom (i.e. far under the lethal dose). The latter hypothesis could be valid for small prey (e.g. of 7.5 mg) which are relatively easily handled by the spider. In contrast, large prey escaped sometimes from the spider (namely 1, 2, 2, and 5 prey items in the 36.0, 48.0, 60.0, and 78.0 mg categories, respectively; first prey attacked).

Weight (mg)	State	p1	p2	p3	p4	p5	p6	p7	p8	p9	p10	p11	p12
5.5	n	0	0	1	1	2	0	0	0	0	0	0	
	i	0	2	3	0	0	1	1	0	0	0	0	
	d	24	20	14	8	5	5	5	2	2	1	1	
7.5	n	1	1	2	0	2	2	3	1	3	2	2	0
	i	1	2	2	3	1	2	2	2	1	1	1	1
	d	22	20	18	13	10	9	6	5	4	4	2	2
9.5	n	0	2	2	0	2	1	1	2	1	1	1	0
	i	0	0	0	2	1	3	2	1	1	1	0	0
	d	12	7	6	4	1	0	0	0	1	0	1	2
11.5	n	1	1	1	2	0	1	0	1				
	i	2	3	1	1	2	1	1	0				
	d	9	8	9	2	1	1	0	0				
13.5	n	0	1	0	2	3	2	1	3	0			
	i	0	1	3	1	1	2	1	0	2			
	d	12	10	8	6	5	4	3	2	2			
15.5	n	3	6	4	6	5	5	3	0	0	1	0	
	i	0	0	2	0	0	0	0	0	1	0	1	
	d	9	5	5	3	4	1	0	1	0	0	0	
17.5	n	4	6	3	2	2	0	1	1				
	i	0	2	3	1	0	0	0	0				
	d	8	2	2	0	0	1	0	0				
19.5	n	1	3	6	3	5	3	2	1	1	1	0	0
	i	1	5	3	3	1	1	1	1	1	0	1	1
	d	10	4	2	2	2	1	0	0	0	0	0	0
24.0	n	2	2	6	6	2	6	4	3	2	1	1	1
	i	2	3	2	2	4	1	2	0	0	1	0	0
	d	8	4	1	1	1	0	0	0	0	0	0	0
30.0	n	3	4	6	4	3							
	i	0	0	1	1	0							
	d	9	3	0	1	0							
Weight (mg)	State	p1	p2	p3	Weight (mg)			State	p1	p2	p3		
36.0	n	2	9	8	60.0			n	5	4	2		
	i	2	2	1				i	3	0	0		
	d	8	1	0				d	4	0	0		
42.0	n	4	8	7	78.0			n	8	6	3		
	i	2	2	0				i	3	1	1		
	d	6	1	1				d	1	0	0		
48.0	n	9	9	9									
	i	1	1	0									
	d	2	0	0									

Table 1. - Number of prey items which are (n) normal, (i) immobilized, or (d) dead, 24h after the bite of a spider. The spiders received successively the prey items (p1) to (p12). Prey weight categories from (5.5 mg) to (78.0

Thus, the "raison d'être" of the venom is especially obvious when a spider subdues a prey which is large and dangerous (e.g. by kicks of the posterior legs).

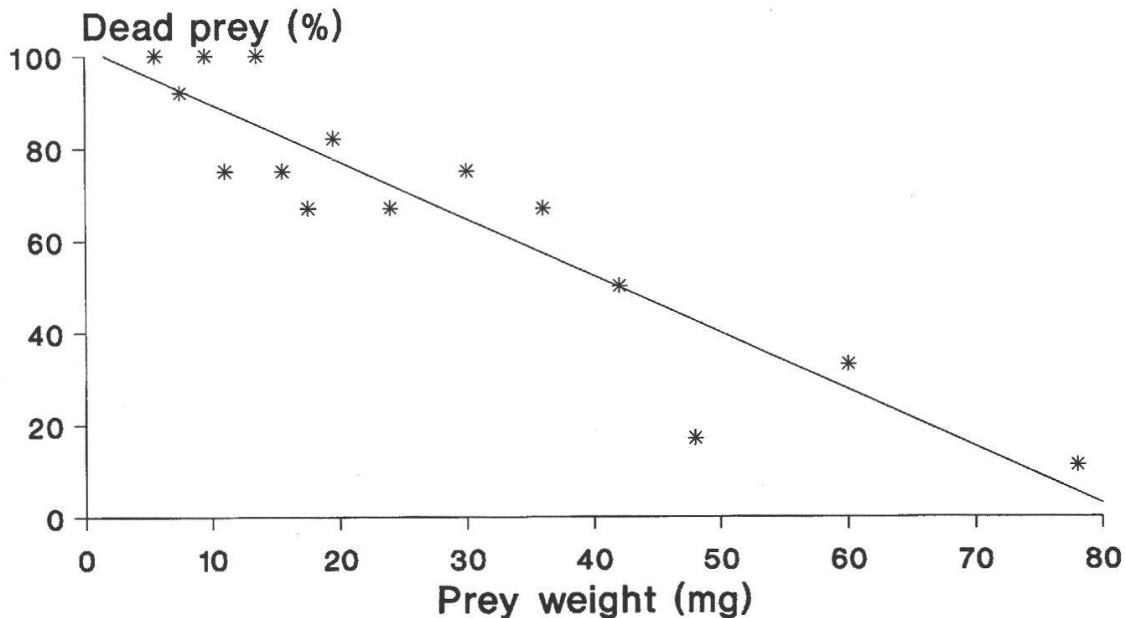


Fig. 2. - Number of dead prey, 24h after the bite of a spider, in function of the prey weight. First attacked prey by the spider. Data refer to table 1.

Mortality (M) of the first attacked prey is linearly correlated with (W), the prey weight ($M = -1.27W + 103$, $r = -0.93$, $P < 0.001$, $n = 15$; figure 2). This suggests that mortality could depends directly on the sensitivity of the prey to one given amount of venom. A spider seems to inject this given amount of venom, i.e. all its venom, in one prey which weighs more than 15.5 mg. The more the prey then increases in size, the more it survives the bite (see figure 2) since it received, proportionally to its weight, less venom.

Thus, the venom glands are emptied, even by giving the spider a series of small (about 7.5 mg) prey. In natural conditions, at least a small amount of venom is probably injected in prey of any size. On the other hand, the spider does not seem to learn, during my experiments, to economize venom when handling one after another relatively undangerous prey items.

3.4 Number of successively attacked prey and prey size

The mean number of prey attacked per spider ranges from 3 to 6 (standard deviation: 2 to 4) in each one of the prey weight categories from 5.5 to 30.0 mg. Very large prey are rarely attacked. The number of spiders, tested in order to obtain 12 attacking at least one prey, was 39 with 78.0 mg prey items, when 12-19 with 9.5-60.0 mg ones. Moreover, large prey are attacked in small numbers (table 1). But the reverse is not necessarily true. For instance, only a few spiders attacked 12 prey items of 7.5 mg

(table 1). There is a rather constant decrease in the number of spiders which attack an increasing number of prey items. Thus, when a prey was taken, the probability that a spider will take a next one remains fairly constant at any moment of the bio-assay. This could be due to the loss of energy, consumed for subduing each prey, and to a behavioural fatigue. In contrast, the availability of venom in the glands does not seem to influence the probability of an attack. Even with glands emptied by successive bites, or by removing the venom (see 3.2.), a spider can attack several prey items.

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The use of faunistical data for biomonitoring

par
Jan Buchar

1. INTRODUCTION

A great diversity of biotopes is a characteristic feature of the Bohemian landscape. Two biotopes with quite different microclimates can be found only a few hundred metres apart. For example, a habitat of the boreal species *Acantholycosa norvegica* is situated not very far from habitats of thermophilic species such as *Zelotes villicus*, *Xysticus robustus*, *Thanatus vulgaris* and others (BUCHAR 1979). This diverse fauna survives even near industrial centres and large farms. Therefore, it is not surprising that many Czechoslovak biologists try to define these relationships and use them in the biomonitoring of the general natural situation.

One of the means of utilising faunistical and floristical data for biomonitoring is the well-known method of square mapping of the occurrence of organisms. Each square has its characteristic faunistical/floristical value expressed by the number of species present (SLAVIK 1980). Long-term studies usually reveal changes indicating anthropogenic influences (MERRETT 1979), and because of this I have focused on species whose occurrence alone is an evidence of high environmental values of their habitats (with a minimal human impact).

References to many papers pointing out the bioindicators value of spiders can be found e.g. in MULHAUSER's (1990) study.

2. METHODS

The grid was based on geographic coordinates, with the squares 6' high and 10' wide, approximate area 130 km². There are almost 400 such squares in Bohemia (443 including very incomplete ones along the borders). Together with a group of arachnologists associated with the Zoological Institute of the Charles University in Prague we investigated 213 squares (figure 1) and their values were assessed according to the:

- 1) occurrence of rare spiders (figure 2) and
- 2) occurrence of rare lycosids (figure 3).

The rare spiders were a set of 62 species always found only in one square (and making up less than 10% of species occurring in Bohemia at the present time). Synanthropic species were not included.

The rare lycosids were a set of 17 species found exclusively in 1 - 12 squares in 1951-1985 (BUCHAR 1986). Presumably, the two groups of species would occur primarily in squares with high socioecological values. The criterion was the proportion of these species in squares situated in large protected landscape areas (figure 4). Twenty five per cent of the investigated squares were in the large protected landscape areas (table I), and therefore the two groups of spiders could be expected to occur there in much larger numbers than in squares situated outside of them, but many of these species were also collected in small state nature reserves in otherwise unprotected landscape.

Table 1.- The proportion of squares situated in protected landscape areas in Bohemia

Category of squares	I	II	III	IV	V	Total
by the number of species found in them	200+	101-200	51-100	6-50	1-5	
Total number of squares investigated in Bohemia	8	18	23	119	45	213
Squares in protected areas	7 88%	5 28%	4 17%	32 27%	5 11%	53 25%

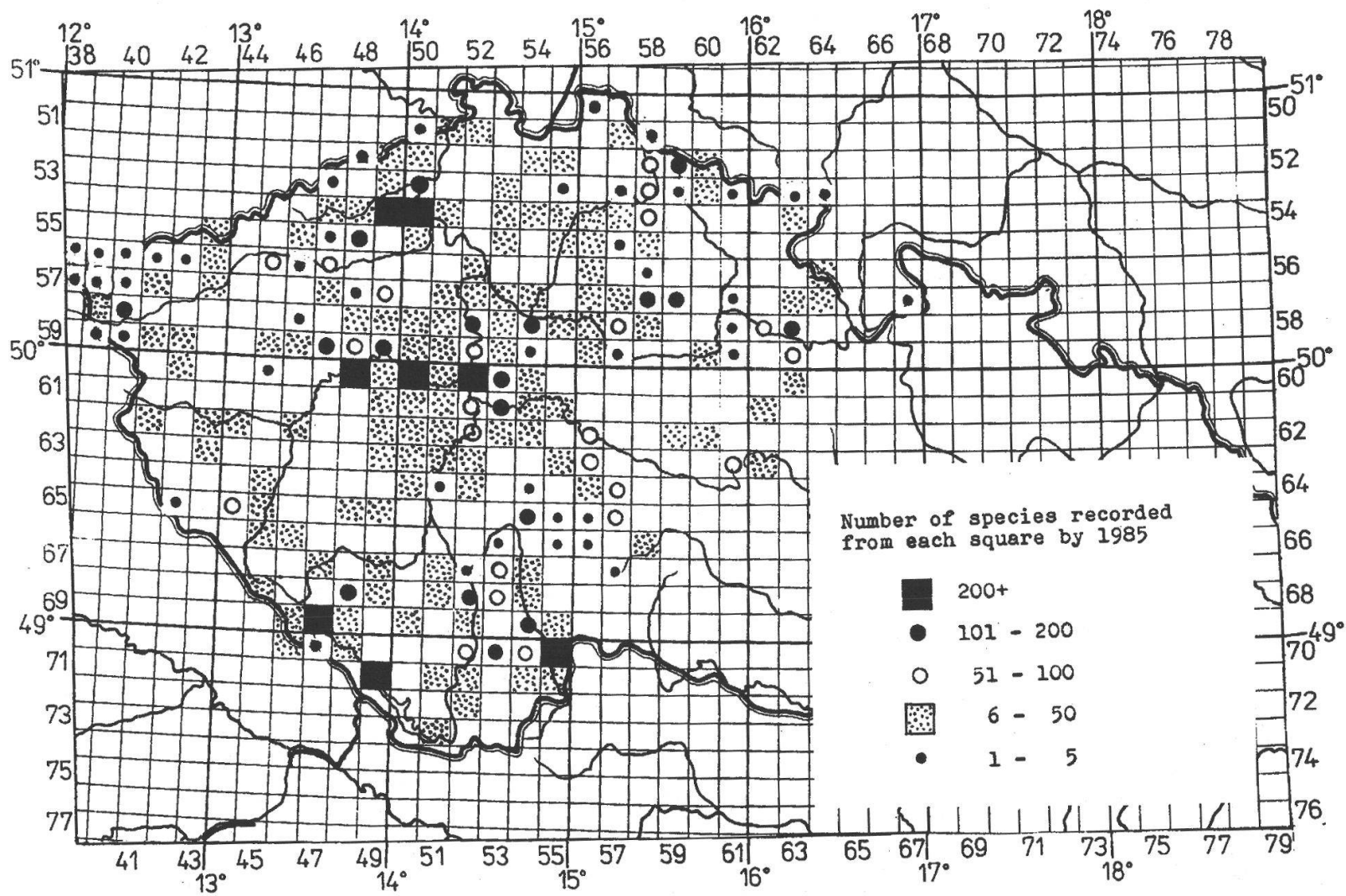


Fig. 1.

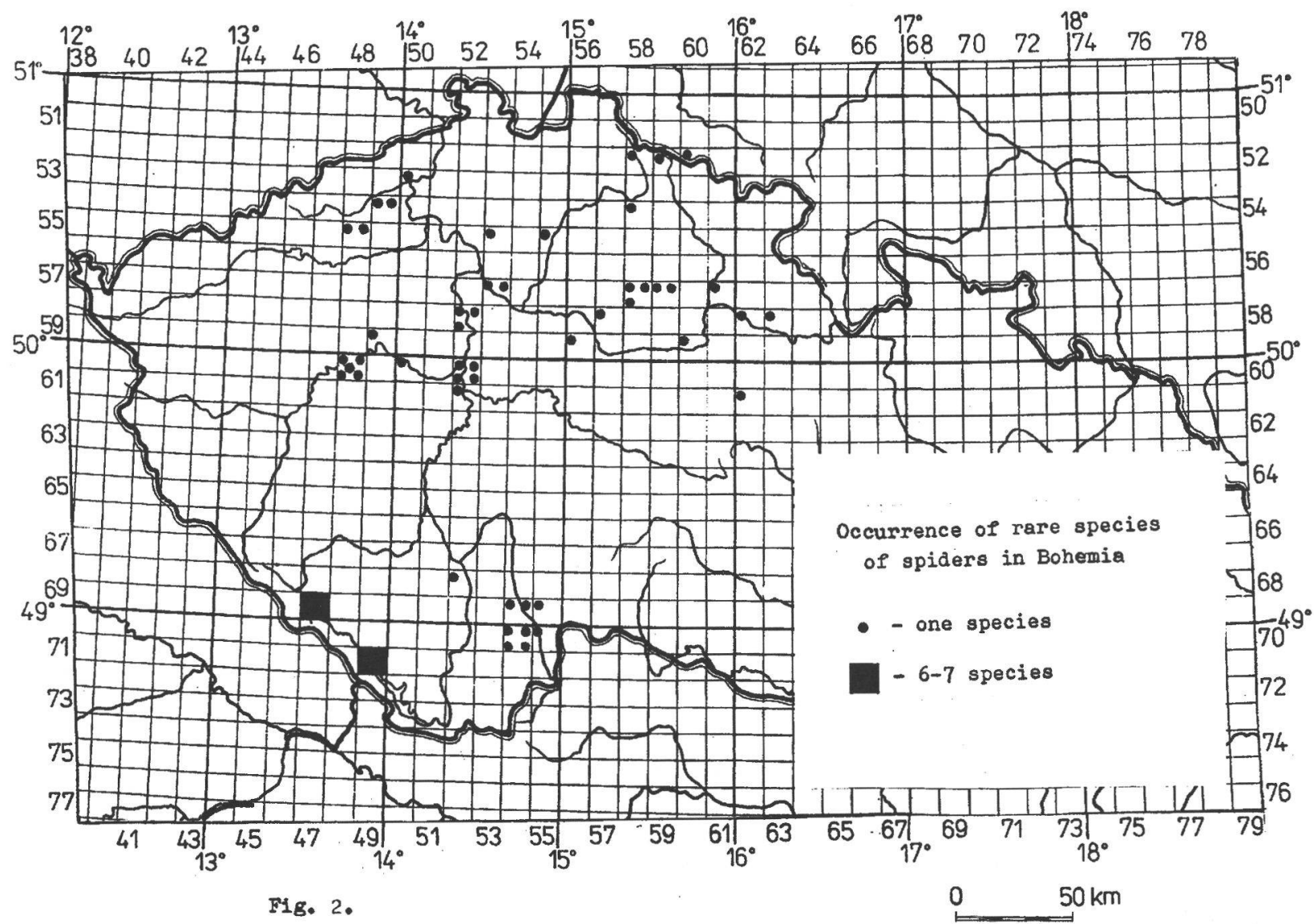


Fig. 2.

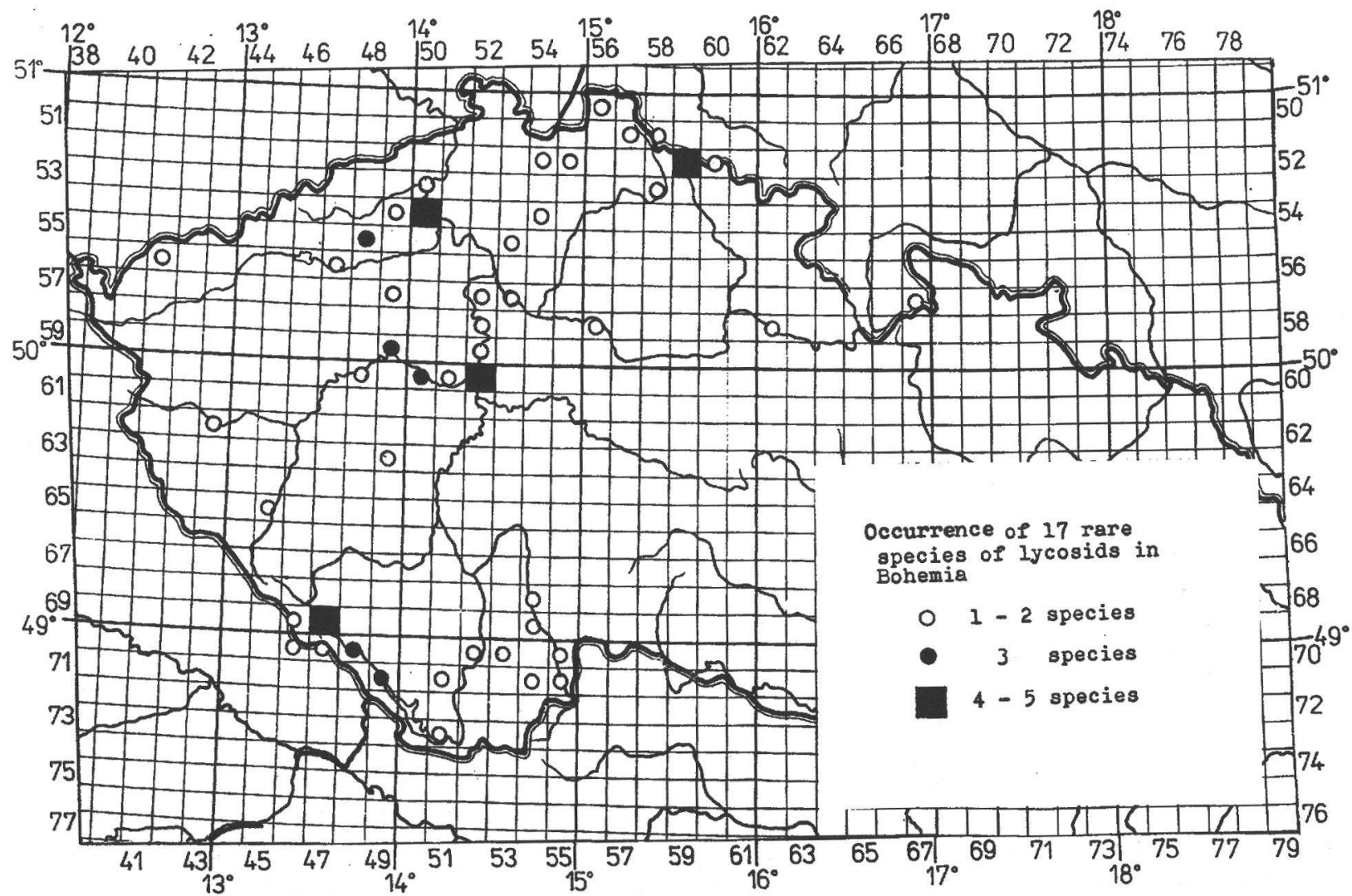


Fig. 3.

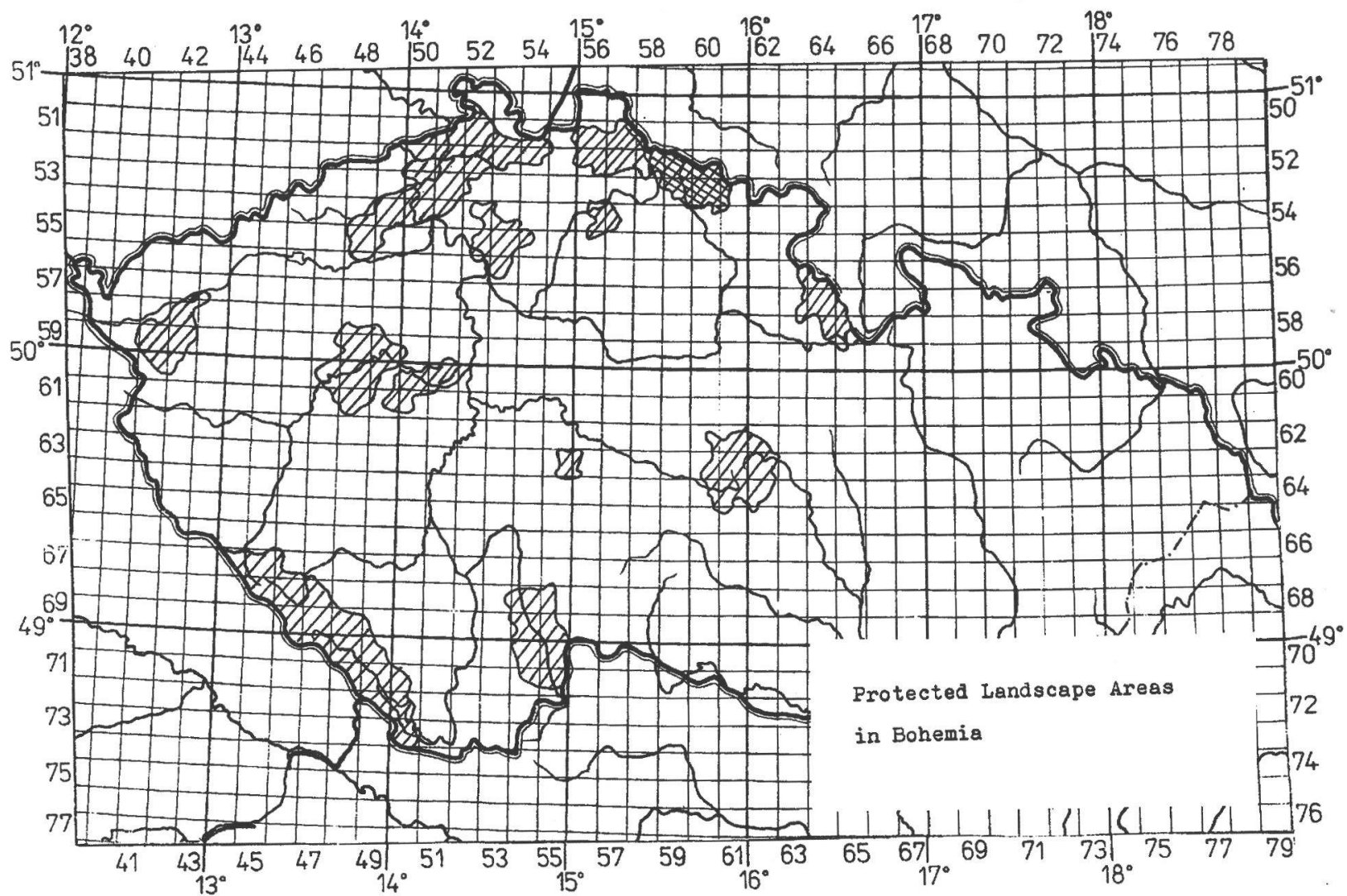


Fig. 4.

0 50 km

3. RESULTS

Sixty two rare spiders were found in 32 squares. Most of species (76%) were in the large protected landscape areas (table II). The minimum of the rare species was found in squares of the lowest category. The numbers gradually increased, so that half the species were found in 7 squares of the highest category (over 200 species).

Eighty four records of 17 rare lycosids were made in 47 squares, 1 - 5 species having been found in each. Over half these squares (53%) were situated in the large protected landscape areas, 62% of the records of the 17 rare lycosids were made in the protected areas and nature reserves (table III). The rare lycosids and the other rare spiders occurred together in 22 squares, 19 of which were in the large protected areas. Only in one case (square 5949) concerned these two aspects one and the same species, *Arctosa maculata*, and different species were involved in the other 18 cases.

Table 2.- The proportion of rare spiders found in protected areas in relation to the whole of Bohemia

Category of squares	I	II	III	IV	V	Total
Total number of squares where rare spiders occur in Bohemia	7	10	6	8	1	32
In protected areas only	6 86%	5 50%	2 33%	3 38%	0	16 50%
Total number of rare spiders in Bohemia	26	17	9	9	1	62
In protected areas only	22 85%	7 41%	5 55%	3 33%	0	47 76%

Table 3.- The occurrence of rare lycosids in protected areas compared with their occurrence in the whole of Bohemia

Category of squares	I	II	III	IV	V	Total
Total number of squares where rare lycosids occur in Bohemia	8	7	6	21	5	47
Category of squares	I	II	III	IV	V	Total
In protected areas only	7 88%	5 71%	0	11 52%	2 40%	25 53%
Records of rare lycosids in total	22	17	8	32	5	84
Records from protected areas	18 81%	14 82%	0	18 56%	2 40%	52 62%

4. CONCLUSION

It follows that the occurrence of rare spiders is a very useful criterion in biomonitoring.

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Résistance à la sécheresse, revêtement tégumentaire et valence écologique de Salticidés

par
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avec la collaboration technique de Jo Le Lannic

Résumé: Une méthode expérimentale est mise au point afin de tester la résistance à la sécheresse des araignées. Parmi les espèces étudiées au moyen de cette méthode, *Aelurillus v-insignitus*, présente une quasi-absence de pertes d'eau en atmosphères sèches. Des explications de cette adaptation aux milieux secs sont fournies par une étude du tégument de différentes espèces de Salticidés au moyen du microscope électronique à balayage. Les soies sont en général d'autant plus denses et larges que les espèces colonisent des milieux secs, leur ensemble constitue, un revêtement dont la surface totale est alors supérieure à celle du tégument sous-jacent. La mise en parallèle du taux de recouvrement par les soies et de la valence écologique connue des différents Salticidés fournit des indications complémentaires à celles déduites à partir des distributions d'espèces.

Summary: An experimental method was devised to test spider resistance to dryness. Among the species studied, *Aelurillus v-insignitus* did not lose any water even in a dry atmosphere. Explanation of this adaptation to life in dry places was found in scanning electronical microscope studies of cuticular hairs. Species that live in dry places possessed larger and more abundant hairs. All their hairs made a cover which had a total surface greater than that of the tegument. The cover ratio gave further indications on the ecological valence of species already established for distribution.

1. INTRODUCTION

A lors que l'abondance et la richesse spécifique des araignées semblent peu élevées lorsque l'humidité du milieu est faible, les Salticidés sont au contraire assez nombreux et abondants en milieux secs. De plus, plusieurs de ces espèces vivant dans des biotopes particulièrement chauds et secs sont actives le jour et ne peuvent pas, de ce fait, se soustraire à la sécheresse ou aux températures élevées. Les Salticidés sont également présents dans les autres types de milieux. En conséquence, l'ensemble de leurs espèces présente une gamme de valences écologiques parmi les plus étendues de tout l'ordre des Aranéides.

Il nous a paru intéressant d'une part de vérifier cette apparente bonne résistance à la sécheresse de certaines espèces de Salticidés, et d'autre part d'en cerner les raisons. Pour cela, nous avons établi un protocole d'analyse expérimentale afin de vérifier s'il existait bien une résistance physiologique à la dessiccation et non des comportements particuliers pour se soustraire aux conditions de sécheresse, ou des apports d'eau insoupçonnés. Les travaux antérieurs concernant les divers éléments de la balance hydrique des arthropodes (EDNEY 1977) ou plus particulièrement des araignées (NEMENZ 1954; CLOUDSLEY-THOMSON 1956; ...) nous ont conduit à développer des recherches sur l'évapo-transpiration avec, dans un premier temps, une étude de la structure du tégument.

Les travaux concernant la valence écologique des espèces, assez développés sur les araignées depuis TRETZEL (1952), sont basés sur la présence des espèces dans les différents milieux. Ils ne permettent pas toujours de faire la part entre les trois éléments liés: sécheresse, chaleur, ensoleillement. Aussi une analyse sur la seule résistance à la sécheresse permet-elle d'évaluer cet élément de la valence écologique en le distinguant des autres. Ainsi, par exemple, une espèce peut apparaître indistinctement xérophile, thermophile ou héliophile en raison des milieux qu'elle colonise. Si elle se révèle physiologiquement non xérophile, sa valence se limite alors à la thermophilie ou à l'héliophilie.

2. MATERIEL ET METHODES

Les espèces étudiées sont choisies parmi les plus communes en Bretagne (COUTANT 1991). Pour l'étude des pertes en eau, nous nous sommes limité à trois espèces qui nous ont paru traduire au mieux la grande gamme de biotopes colonisés, ce sont: *Aelurillus v-insignitus* (milieux secs), *Euophrys frontalis* (milieux mésophiles à végétation dense) et *Sitticus floricola* (milieux humides). Le tégument a été observé chez 11 espèces: *Aelurillus v-insignitus* (Lucas, 1846), *Dendryphantès rudis* (Sundevall, 1832), *Euophrys frontalis* (Walckenaer, 1802), *Euophrys petrensis* Koch C.L., 1837, *Heliophanus flavipes* (Hahn, 1831), *Heliophanus tribulosus* Simon, 1868, *Marpissa nivoyi* (Lucas, 1846), *Myrmarachne formicaria* (De Geer, 1778), *Phlegma fasciata* (Hahn,

1826), *Salticus scenicus* (Clerck, 1758) et *Sitticus floricola* (Koch C.L., 1837). Les pertes en eau sont étudiées grâce à un montage (figure 1) dont l'élément essentiel est une balance de précision (Mettler au 1/100mg) muni d'un système d'enregistrement des variations pondérales. Les individus étudiés sont tout d'abord maintenus 24 heures à jeun dans une enceinte à humidité saturante, puis placés dans des capsules grillagées métalliques afin qu'ils ne s'échappent pas et introduits sur le plateau de la balance. La balance est enfermée dans un espace translucide où l'humidité est contrôlée par un compartiment de "régulation hydrique" contenant une solution de potasse dont la concentration permet d'obtenir le taux d'humidité voulu. Humidité et température sont contrôlées par une sonde. L'ensemble de l'appareillage est situé dans une pièce elle-même climatisée (20°C).

Les résultats fournis concernent la moyenne des pertes de 5 individus par espèces. Les observations du tégument ont été réalisées au microscope électronique à balayage, les échantillons étant préparés par la méthode du point critique. La densité et la surface des soies ont été calculées à partir de photographies prises en microscopie électronique.

3. RESULTATS

3.1 Analyse des pertes en eau

Les pertes pondérales évoluent très différemment suivant les espèces étudiées (figure 1): *Sitticus floricola* perd, dans un air à 70-80% H.R., une quantité d'eau

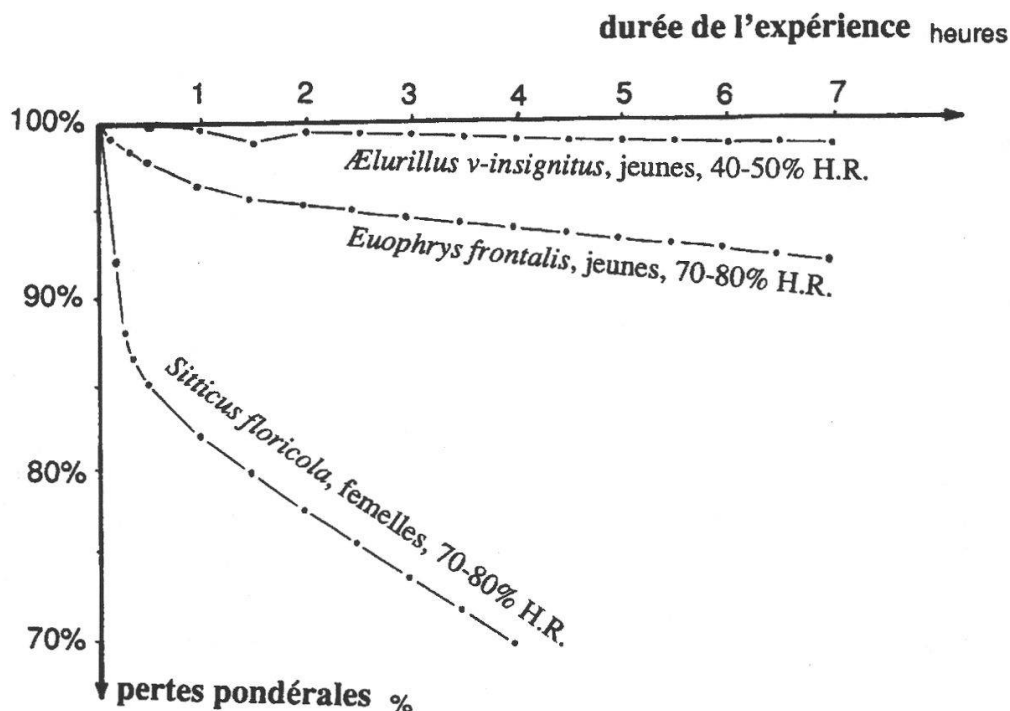


Fig. 1 : Pertes en eau chez des Salticidés soumis à des milieux d'humidités relatives contrôlées

considérable dépassant 30% de son poids en 4 heures; *Euophrys frontalis*, soumis aux mêmes conditions hydriques, perd moins de 10% en 7 heures, alors que *Aelurillus v-insignitus* ne perd quasiment pas de poids, même lorsque les individus subissent des humidités relatives de 40-50%.

3.2 Observation du revêtement tégumentaire

Le revêtement tégumentaire est très différent suivant les espèces. Les variations jouent à la fois sur la densité des soies et leur forme (planche I, tableau I).

Tab. I: nombres de soies par unité de surface (n), surface moyenne des soies (s) et taux de recouvrement maximal du tégument par les soies du dos de l'abdomen (Tx).

Espèces	soies/mm2	surf. soie (m2)	taux de recouvr. (Tx)
<i>Myrmarachne formicaria</i>	220	70	2%
<i>Sitticus floricola</i>	810	30	2%
<i>Euophrys frontalis</i>	540	48	3%
<i>Euophrys petrensis</i>	3300	31	10%
<i>Heliophanus flavipes</i>	900	230	21%
<i>Marpissa nivoyi</i>	1350	340	46%
<i>Heliophanus tribulosus</i>	1400	400	56%
<i>Phlegra fasciata</i>	1710	510	87%
<i>Aelurillus v-insignitus</i>	1760	510-630	90-111%
<i>Dendryphantes rudis</i>	1720	720	124%
<i>Salticus scenicus</i>	1070	1330	142%

La densité des soies, calculée sur le tégument du dos de l'abdomen, c'est-à-dire dans une région du corps où l'exocuticule manque et où l'endocuticule est fine (BARTH in FOELIX 1979), varie dans une proportion de 1 à 15. La forme des soies varie aussi considérablement, elles sont longues et fines chez *Myrmarachne formicaria* ou *Sitticus floricola*, larges, en forme d'écailles, chez les autres espèces où elles atteignent leur surface maximale chez *Salticus scenicus*. Dans plusieurs cas, le bord des soies est denté. Ces structures peuvent permettre un accrochage des soies entre-elles (*Aelurillus v-insignitus*). Le taux de recouvrement maximum des soies (Tx), calculé à partir de leur nombre (n) et de leur surface (s): $Tx = n \times s / \text{surface du tégument}$, est supérieur à 100% chez plusieurs espèces. Ce recouvrement du tégument par une couche de soies est une protection évidente contre le rayonnement solaire. Cette "isolation par l'extérieur", semblable aux processus employés dans les constructions humaines, permet aussi de limiter les pertes en eau.

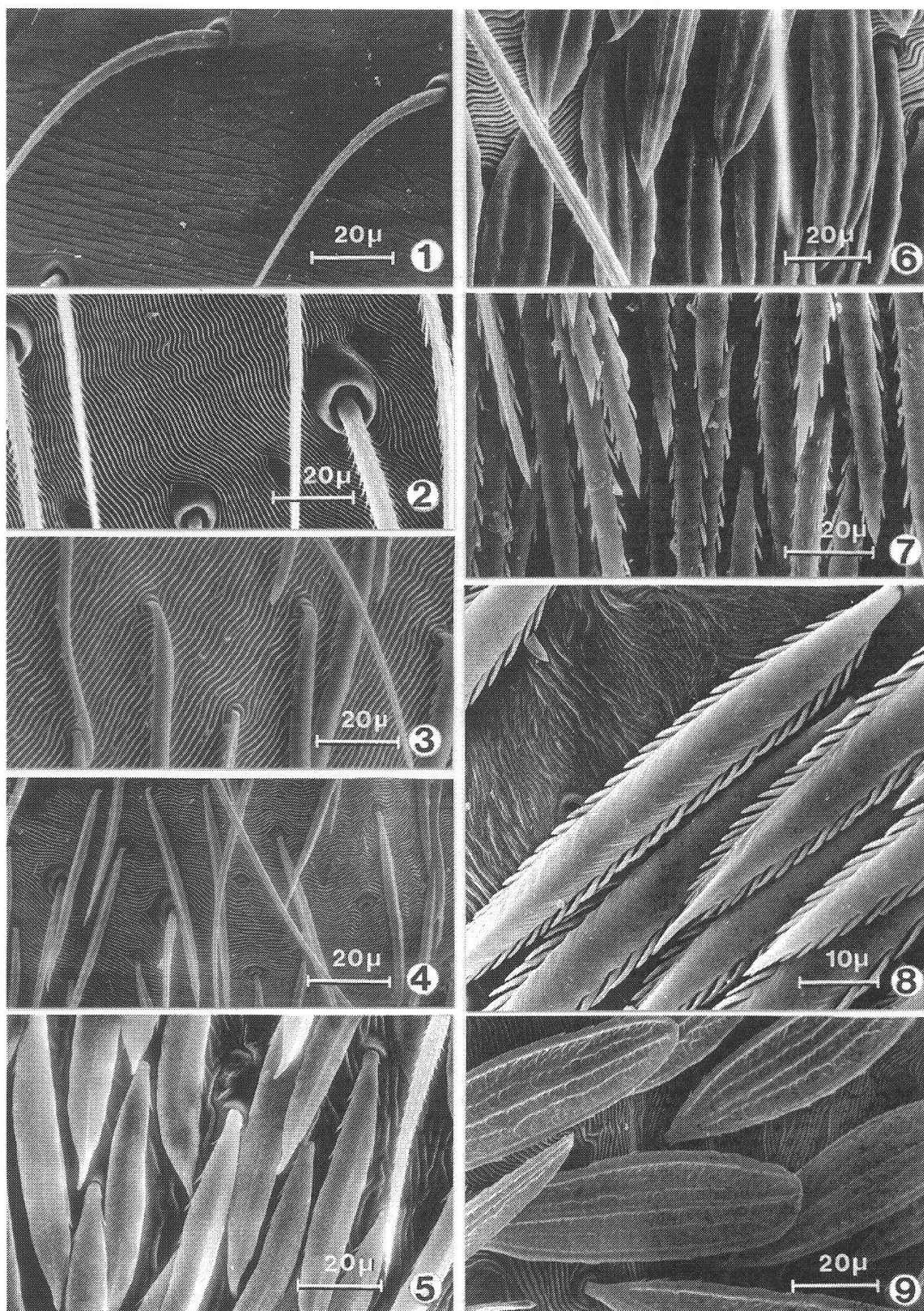


Planche I : Revêtement tégumentaire de l'abdomen de Salticidés, - 1 *Myrmarachne formicaria*, - 2 *Euophrys frontalis*, - 3 *Sitticus floricola*, - 4 *Euophrys petrensis*, - 5 *Heliophanus tribulosus*- 6 *Dendryphantès rudis*, - 7 *Phlegra fasciata*, - 8 *Aelurillus v-insignitus*, - 9 *Salticus scenicus*.

4. DISCUSSION-CONCLUSION

La méthode expérimentale employée fournit des résultats qui paraissent intéressants, même s'ils ne sont encore qu'indicatifs. Elle nous permet ici de mettre en évidence la très bonne résistance à la sécheresse d'*Aelurillus v-insignitus*. Il est encore possible d'améliorer la technique, notamment en remplaçant le module d'enregistrement par un ordinateur couplé grâce à une interface adéquate. Le seul problème que nous ayons rencontré correspond à un rejet intempestif d'excréments (au total un seul cas observé, chez *Aelurillus v-insignitus*); car la perte pondérale ne correspondant plus alors seulement aux pertes hydriques. Dans les résultats, les pertes pondérales dues aux échanges gazeux (O₂-CO₂) doivent être négligées. En se basant sur des intensités respiratoires élevées (BLANDIN & CELERIER 1981), les pertes dues à ces échanges sont de l'ordre de 0,01%/heure (IR = 0,030 mm³/mg/h). L'étude expérimentale de la résistance à la sécheresse présente l'intérêt de dissocier, pour estimer la valence écologique, les trois facteurs liés au cours des analyses à partir de la seule distribution des espèces: chaleur-ensoleillement-sécheresse.

Les économies d'eau que peuvent réaliser les espèces résistantes à la sécheresse, par rapport aux autres, portent sur la nature des produits excrétés et sur les pertes d'eau par la respiration et par l'évapo-transpiration. Les différences de pertes en eau dues à l'excrétion ne pourraient jouer que sur la concentration des éléments rejetés, car en ce qui concerne le métabolisme azoté, le seul élément trouvé chez toutes les espèces d'araignées étudiées est la guanine (ANDERSON 1966). Les différences de pertes en eau dues au système respiratoire pourraient être intéressantes à évaluer, d'autant plus que l'appareil trachéen des Salticides est particulièrement développé (LAMY 1902) et que le système trachéen est plus performant que le système pulmonaire (LEVI 1967). Toutefois NEMENZ (1954), dans son étude sur les pertes en eau des araignées, avance que les pertes d'eau par la respiration ne dépassent pas le 1/70e ou le 1/80e de la perte totale.

On peut donc considérer que la limitation des pertes en eau dues à l'évapo-transpiration est particulièrement importante dans l'adaptation des espèces à la sécheresse. Elle peut se réaliser, comme chez beaucoup d'autres arthropodes par une augmentation des barrières tégumentaires. Mais chez les araignées, l'opisthosome est extensible, ce qui limite les possibilités d'épaississement cuticulaire. La réponse évolutive par développement d'une barrière à l'évaporation au moyen d'une couche de soies est donc particulièrement efficace.

En ce qui concerne le revêtement tégumentaire, les valeurs calculées du taux de recouvrement par les soies doivent être considérées comme étant seulement indicatives, car la surface du tégument abdominal est variable suivant le degré de dilatation de cette partie du corps. Toutefois, une mise en parallèle des valeurs de ce taux et de la valence écologique connue des espèces fournie par différents auteurs (tableau II) semble assez concordante.

Espèces	Tx	valence écologique	auteurs
<i>Myrmarachne formicaria</i>	2%	photophile, thermophile	(BRAUN, 1970)
<i>Sitticus floricola</i>	2%	photophile, hygrobionte	(TRETZEL, 1952)
<i>Euophrys frontalis</i>	3%	hémionbrophile, hémihygrophile	(TRETZEL, 1952)
<i>Euophrys petrensis</i>	10%	hémionbrophile, hémihygrophile (?)	(TRETZEL, 1952)
<i>Heliophanus flavipes</i>	21%	photophile, xérophile thermophile	(TRETZEL, 1952) (BRAUN, 1970)
<i>Marpissa nivoyi</i>	46%	hygrophile (?)	
<i>Heliophanus tribulosus</i>	56%	photophile, xérophile (?)	(CANARD, 1984)
<i>Phlegma fasciata</i>	87%	photophile, xérophile	(BRAUN, 1970)
<i>Aelurillus v-insignitus</i>	90-111%	photophile, xérophile (?)	(TRETZEL, 1952)
<i>Dendryphantès rudis</i>	124%	photophile, xérophile (?)	(CANARD, 1984)
<i>Salticus scenicus</i>	142%	thermophile	(TRETZEL, 1952)

Tab. II: Mise en parallèle du taux de recouvrement par les soies du tégument du dos de l'abdomen (Tx) et de la valence écologique des espèces données dans quelques travaux.

Les seuls résultats, en apparence non conformes, sont ceux concernant *Myrmarachne formicaria* et *Marpissa nivoyi*. Mais, dans les deux cas, il peut s'agir d'une évaluation trop approximative ou incomplète de la distribution de ces espèces. Ainsi, *Myrmarachne formicaria* est présente dans des milieux variés, mais fréquente des strates où l'humidité relative est élevée, ce qui n'exclut pas une certaine hygrophilie. De plus, l'aspect du tégument abdominal de cette myrmécomorphe est un peu différent des autres espèces et apparaît moins plissé. Aussi peut-on envisager une structure originale de sa cuticule. *Marpissa nivoyi*, peu fréquente en Europe moyenne (HARM 1977), est assez commune en Bretagne en bordure de mer ou d'étangs dans des zones de hautes graminées (*Ammophila arenaria*, *Molinia caerulea*). On pourrait la définir comme plutôt hygrophile. Toutefois, nous l'avons aussi récoltée dans des milieux en apparence très secs, dans les Causses, où elle fréquente aussi des zones de hautes graminées. Cette espèce est donc certainement plus euryhygre qu'il n'apparaît de prime abord, ce qui correspond à la valeur intermédiaire de son taux de recouvrement en soies. Bien que le revêtement tégumentaire des Salticidae n'explique pas à lui seul la résistance à la dessiccation observée chez certaines espèces, il fournit tout de même une bonne indication sur leur possible adaptation à des milieux secs.

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Le dimorphisme sexuel des Palpigrades

par
Bruno Condé

Résumé: Le dimorphisme sexuel des Palpigrades, les caractères de l'aire génitale exceptés, est présenté et discuté. Il tire sa principale origine de complexes glandulaires et de leurs phanères, présents sur les sternites IV à VI de l'opisthosome des femelles adultes. Très saillant chez certains genres (*Koeneniodes*, *Prokoenenia*), il est plus discret ailleurs. Selon MILLOT, l'histologie des glandes ventrales de *Eukoenenia mirabilis* évoque certaines glandes séricigènes d'araignées. Les sécrétions jouent très probablement un rôle dans les processus de la reproduction qui nous sont malheureusement inconnus.

Summary: The sexual dimorphism in Palpigrades, apart from the genital area, is reviewed and discussed. It originates mostly from glandular systems and their setae located on opisthosomian sternites IV-VI of the adult females. Very conspicuous in some genera (*Koeneniodes*, *Prokoenenia*), it is rather modest in others. According to MILLOT, the histology of the ventral glands of *Eukoenenia mirabilis* is reminiscent of the silk-glands of some spiders. The secretions share very probably in breeding process which were unfortunately never watched.

1. INTRODUCTION

Le sexe d'un Palpigrade est à présent reconnaissable sans ambiguïté, par les caractères de l'aire génitale, dès le deuxième stade, désigné par B pour la femelle et C pour le mâle, ou à partir du troisième seulement, si le premier (A), sans volets génitaux différenciés, est dédoublé en A1 et A2, comme dans le genre *Prokoenenia*.

Il existe aussi des variants sexuels secondaires qui ont le plus souvent pour siège les sternites IV à VI de l'opisthosome des femelles adultes, les mâles retenant en général les caractères du stade juvénile B ou C, si ce dernier est différent. Récemment, un variant sexuel séparant le mâle de la femelle dès le deuxième stade a été mis en évidence sur le basitarse IV de deux espèces du genre *Koeneniodes*.

2. VARIANT SEXUEL DU PROSOME (BASITARSE IV)

L'existence de ce variant, soupçonnée en comparant une femelle B à un mâle C de *Koeneniodes berndi* Condé, le premier mâle connu dans le genre *Koeneniodes* (CONDÉ 1988: 743, fig. 14 C, D et 747), fut confirmée par l'examen de 30 spécimens de Sulawesi (6 mâles dont un juvénile, 24 femelles dont 7 juvéniles), appartenant à *K. frondiger* Remy, l'espèce la plus voisine de *K. berndi*.

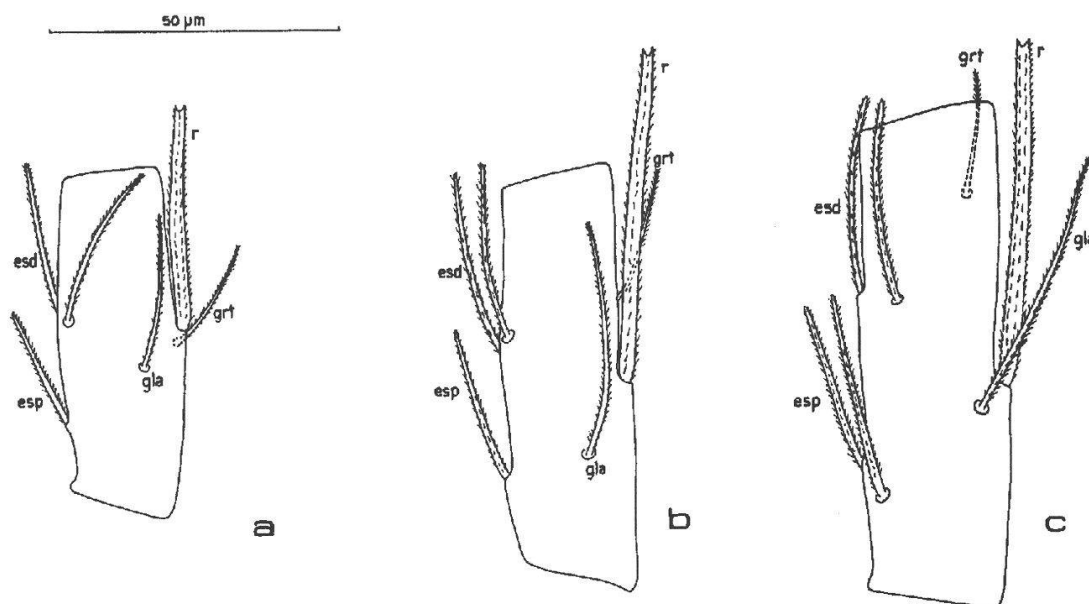


Fig. 1. - *Koeneniodes berndi* Condé, basitarse IV. a. Mâle juvénile C.- b. Femelle juvénile B.- c. Femelle adulte. Explication des lettres dans le texte. D'après CONDÉ 1988.

Chez le mâle (figure 1a), la soie grêle tergale (grt) est insérée vers le milieu du bord tergal du basitarse, au voisinage de la soie raide (r); chez la femelle (figure 1b), grt est le phanère le plus distal du basitarse et son déplacement vers l'apex s'accroît entre le juvénile et l'adulte (figure 1c); en même temps, la longueur relative de grt à gla (soie grêle latérale antérieure) passe des 2/3 à la moitié ($gla/grt = 1,54$ à $2,08$); chez le mâle, la valeur moyenne de ce rapport est 1,45 (une seule fois 1).

Les mâles des cinq autres espèces de *Koeneniodes* sont encore inconnus. Le basitarse de *K. notabilis* Silvestri, l'espèce-type, et celui de *K. malagasorum* Remy n'ont pas été décrits en détail; parmi les autres espèces, celui de *K. deharvengi* Condé, possédant une grt distale, pourrait présenter un dimorphisme analogue.

3. VARIANTS SEXUELS DE L'OPISTHOSOME DES FEMELLES (STERNITES IV À VI)

La première mention de ce type de variant est due à SILVESTRI (1905) quand il décrit le mâle de *Eukoenenia berlesei* (sous *mirabilis*) et note l'absence des poils glandulaires que la femelle adulte porte au milieu du sternite IV.

3.1 Sternite IV

Dans le complexe *E. mirabilis-berlesei*, des poils coniques, au nombre de 3 à 6, forment une sorte de pinceau médian, à pointe dirigée vers l'arrière, qui surmonte une glande volumineuse (glande ventrale antérieure de MILLOT 1942). Le statut des femelles de *E. mirabilis* dépourvues de ces formations, comme les juvéniles et le mâle adulte, n'a pas encore pu être établi de façon satisfaisante (CONDÉ 1991).

3.2 Sternite VI

E. lawrencei (Remy) porte 3 paires de soies épaisses et recourbées vers l'avant, associées à une paire de gros massifs glandulaires qui débordent largement dans le segment VII (figure 2a). La femelle juvénile, décrite par REMY (1959: 257, sous "catégorie A") présente déjà cette disposition. Les mâles, adultes ou juvéniles, n'ont que 2 paires de soies dirigées vers l'arrière, comme aux sternites IV et V dans les deux sexes.

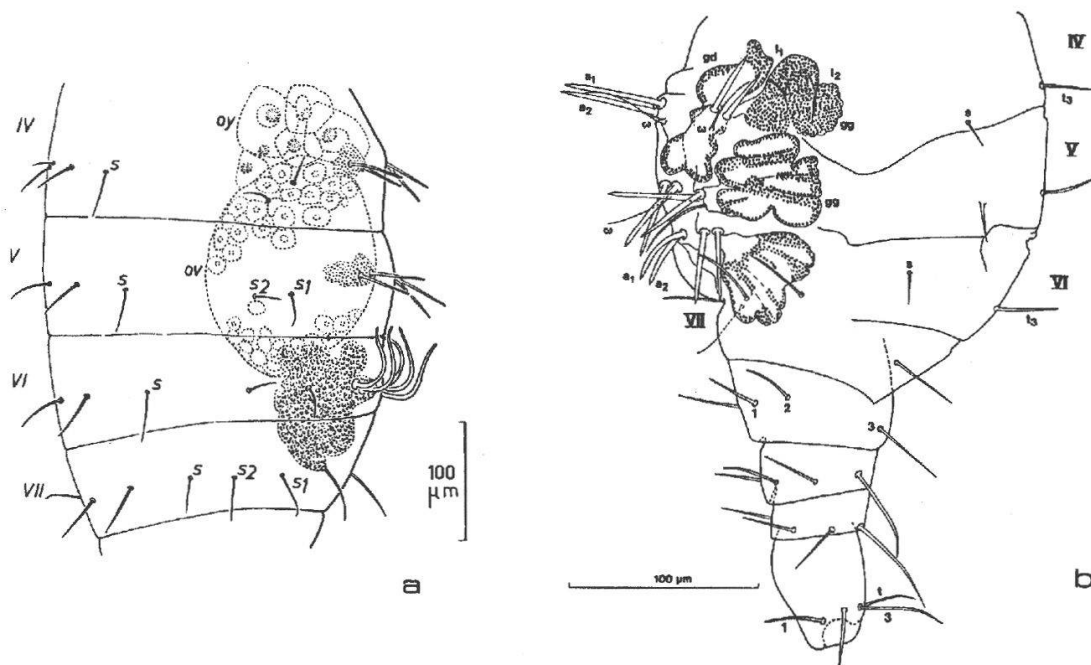


Fig. 2. - Opisthosome en vue latérale, montrant les massifs glandulaires IV à VI et les phanères excréteurs. a. *Eukoenenia lawrencei* (Remy), femelle adulte; ov et oy: ovaire et ovocytes.- b. *Prokoenenia javanica* Condé, immature A; a1, a2: phanères excréteurs; gg, gd: massifs glandulaires droit et gauche. D'après CONDÉ 1981 et 1990.

3.3 Sternites IV à VI

Chez une espèce de *Eukoenenia* d'Amazonie, en cours d'étude, la femelle adulte acquiert une troisième paire de phanères glandulaires sur chacun des sternites, le mâle conservant les deux paires des juvéniles des deux sexes.

Dans le genre *Koeneniodes*, les femelles adultes ont acquis sur les sternites IV à VI, plus ou moins coalisés, des structures glandulaires souvent remarquables sur lesquelles se fonde en partie la systématique des espèces. La découverte des premiers mâles adultes de *K. frondiger* Remy, met en question la détermination spécifique d'un mâle isolé puisque, chez cette espèce au moins, le mâle demeure conforme à un juvénile B ou C, dépourvu des formations qui seront caractéristiques de l'espèce.

Le complexe *frondiger-berndi* possède le dispositif le plus compliqué (figure 3), comprenant en IV et V un volumineux organe tubulaire érectile, terminé par 16 phanères épais, taillés en biseau, et 2 phanères grêles; des protubérances latérales au sternite IV, pourvues de 2 phanères apicaux, l'un foliacé, l'autre falciforme, et des formations semblables au sternite V, portant à l'apex un phanère foliacé et un crochet de forme plus ou moins compliquée. Une énorme masse glandulaire occupe les segments III à V et alimente, en particulier, les phanères du tube érectile.

Curieusement, les 4 phanères glandulaires sétiformes, épais et dirigés vers l'avant, portés en VI par les juvéniles et le mâle, ainsi que le massif glandulaire correspondant, manquent chez la femelle adulte, remplacés par un nombre égal de phanères dilatés, non sécréteurs.

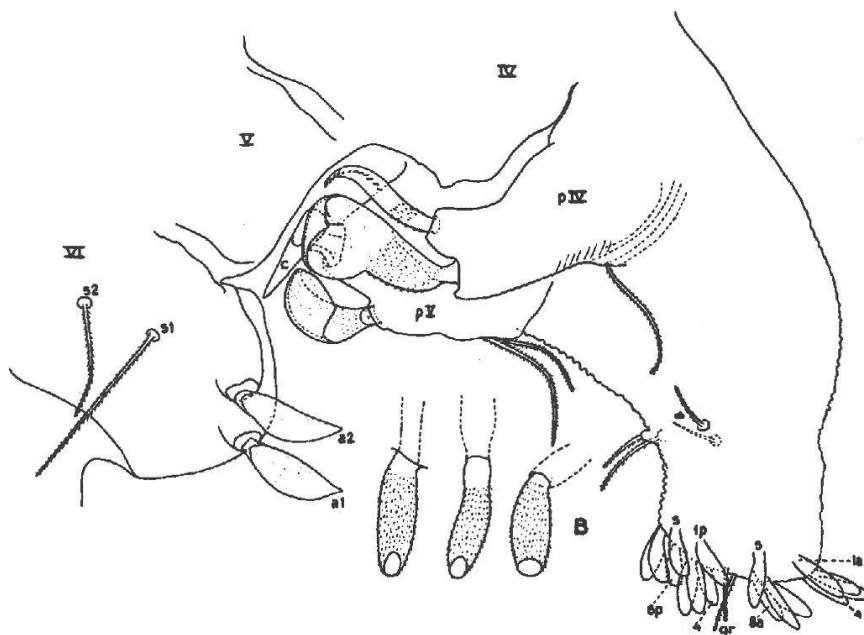


Fig. 3.- *Koeneniodes berndi*, femelle adulte. Opisthosome en vue latérale, montrant le tube érectile et ses phanères, et les protubérances des sternites IV et V. D'après CONDÉ 1988.

Chez *Koeneniodes madecassus* Remy, une comparaison entre la femelle juvénile et l'adulte montre, chez cette dernière, l'acquisition en IV d'un groupe de 15-16 phanères glandulaires, sur un dôme médian (? extrémité d'un tube érectile), et la perte de la rangée de phanères brusquement élargis à l'apex (claviformes ou en palettes), non glandulaires; ces derniers se retrouvent en V, à la place des phanères subcylindriques, épais et glandulaires du juvénile; en VI, il existe en commun un rang de 5 phanères plus longs et plus grêles que ceux des autres sternites. Les massifs glandulaires n'ont pas été décrits chez l'adulte, mais il en existe certainement en IV, au moins, en relation avec les phanères du dôme. Chez les juvéniles, un massif glandulaire allongé est situé sous la rangée de phanères des sternites V et VI. Le remaniement du sternite IV est comparable à ce que l'on observe chez *K. frondiger*.

Koeneniodes spiniger Condé présente trois rangées rapprochées de 4 gros phanères chacune, appartenant respectivement aux sternites IV, V et VI dont les limites sont effacées; l'ensemble forme une protubérance médio-ventrale, chaque rangée surmontant un volumineux massif glandulaire (CONDÉ 1984, fig. 8). Chez la femelle juvénile ou l'immature A, les rangées sont beaucoup plus espacées et les limites segmentaires nettes (loc. cit., fig. 9). Par comparaison avec *K. frondiger*, on peut supposer qu'il en serait de même chez le mâle adulte.

Dans la lignée prokoenénienne, des phanères glandulaires sont aussi présents de IV à VI: une seule paire chez *Prokoenenia millotorum* Remy ou 2 à 7 paires chez les autres espèces.

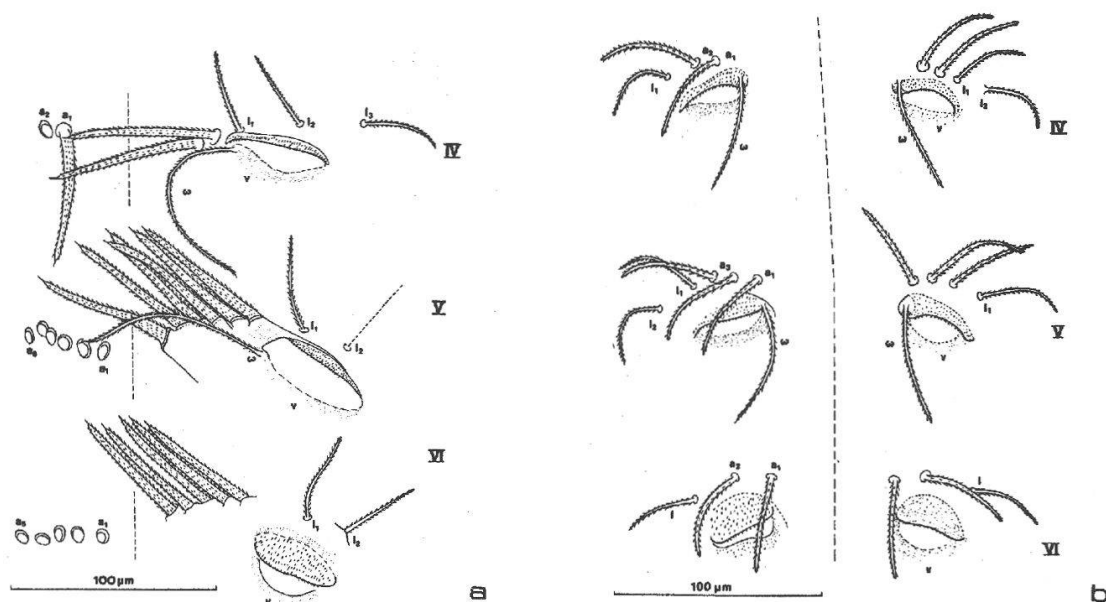


Fig. 4.- *Prokoenenia javanica* Condé, sternites IV à VI. a. Femelle adulte.- b.Mâle adulte. a1-a8: phanères excréteurs de la femelle; a1-a3: phanères ordinaires du mâle; v: orifice d'une vésicule exsertile. D'après CONDÉ 1990.

Chez *P. javanica* Condé 1990, l'immature A possède déjà une paire de massifs glandulaires de IV à VI, chaque massif étant surmonté de 2 phanères épais (figure 2b); une disposition analogue a été constatée chez les femelles, juvénile B et adulte, de cette espèce, le nombre de phanères étant seulement plus élevé à certains sternites (figure 4 a); l'immature A2 et le juvénile C d'une espèce voisine (*P. celebica* in litt.) sont comparables, avec 2 à 4 soies excrétrices par massif. En revanche, chez le mâle adulte de *javanica*, seul représentant de ce stade dans notre matériel, les massifs glandulaires manquent et les gros phanères excréteurs de la femelle et de l'immature A sont remplacés par des poils ordinaires, plus minces et pointus (figure 4b).

4. STERNITES IV À VI DES MALES

La présence de phanères excréteurs particulièrement nombreux sur certains sternites a été signalée chez le mâle de quelques espèces, mais à une exception près et dans l'état actuel de nos connaissances, on ne peut en déduire qu'il s'agisse d'un variant sexuel, soit que la femelle correspondante fût inconnue, soit que la variation parût accidentelle. La première éventualité est illustrée par *E. pretneri* Condé 1977 dont le type porte 10 ou 12 phanères en IV et V, et *E. bonadonai* Condé 1979 dont les sternites IV à VI du type sont pourvus respectivement de 23, 27 et 25 phanères. La seconde concerne un mâle de *E. mirabilis*, étudié par REMY (1948a: 256), qui présente un "râteau" de 31 gros poils glandulaires sur le sternite VI, à la place des 6 ou 7 habituels. Reste le cas de *E. hansenii* (Silvestri), au Mexique, chez lequel REMY (1948b: 35) a compté 8 à 17 phanères (14 chez le type) en IV et 4 à 14 (10 chez le type) en V, la femelle en ayant constamment 8 (4 + 4) à chacun des sternites. J'ai admis (CONDÉ 1979: 906) qu'il s'agissait là d'un variant sexuel incontestable, quoique sa variabilité individuelle contraste avec la stabilité des variants des femelles.

5. CONCLUSION

Le dimorphisme sexuel des Palpigrades a pour origine presque exclusive la présence, chez la femelle adulte, de structures glandulaires héritées de la femelle juvénile ou acquises au dernier stade. Chez *Prokoenenia javanica*, la perte, par le mâle adulte, de phanères et de glandes jusque-là en commun, détermine la dissemblance. Les différences, très marquées chez certaines espèces des genres *Koeneniodes* et *Prokoenenia*, par exemple, sont discrètes ailleurs. Dans les cas les plus favorables, le dimorphisme permet une distinction des sexes sous la loupe binoculaire. Les glandes des femelles, plus nombreuses en général que celles des mâles, jouent très vraisemblablement un rôle dans les processus de la reproduction. MILLOT (1942) a noté qu'elles évoquent, par leur structure, certaines glandes séricigènes d'araignées et que la sécrétion de soie ne serait d'ailleurs pas étonnante dans ce groupe. On n'en sait malheureusement pas davantage.

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***Psilochorus simoni* (Berland, 1911) (Araneae, pholcidae): Découvertes de nouvelles stations suisses et discussions de son écologie**

par
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Gilles Blandenier**

Summary: In 1954, COMELLINI has found *Psilochorus simoni* (Berland, 1911) for the first time in Switzerland (Geneva). Since this date, the species has never been mentioned in this country.

During spring 1991, the authors have discovered 4 new stations in the "canton de Neuchâtel", and have confirm a not published determination from 1985. The populations of four stations show a very high density ($n > 100$ ind.). All the localities have the same microclimatic conditions.

The european faunistic data are analysed and the ecology of this synanthrop species is precised.

1. DISTRIBUTION EN EUROPE

La première découverte et la description de *Psilochorus simoni* (fig. 1) datent de 1911. L'espèce a été récoltée dans la cave du laboratoire d'anatomie comparée de la Sorbonne (Paris). Depuis, différents auteurs l'ont observée un peu partout en Europe: DALMAS (1915), BRISTOWE (1933), plusieurs données dans BONNET (1945), COMELLINI (1954), DENIS (1960), DZIABASZEWSKI (1967), LEDOUX (1967), KRITSCHER (1969), BRIGNOLI (1971), KLAUSEN (1972), DRESCO (1973), MORITZ (1973), BRIGNOLI (1979), MERRETT (1979), SACHER (1983), VOSSEN (1983), RANZY et BAERT (1987), KOOMEN (1988), PRINSEN (1989), JONSSON (1990), YSNEL (1991).

La figure 2 donne un aperçu des connaissances actuelles de sa distribution. Cette espèce a été signalée, au moins une fois, dans tous les pays d'Europe centrale. Elle semble

plus fréquente dans les régions centrales de l'Europe que dans le nord ou le sud. A l'exception d'une grotte italienne dans laquelle 1 mâle et 2 femelles ont été signalés (BRIGNOLI, 1979), toutes les autres citations proviennent de "constructions humaines" (maisons, souterrains, ...).

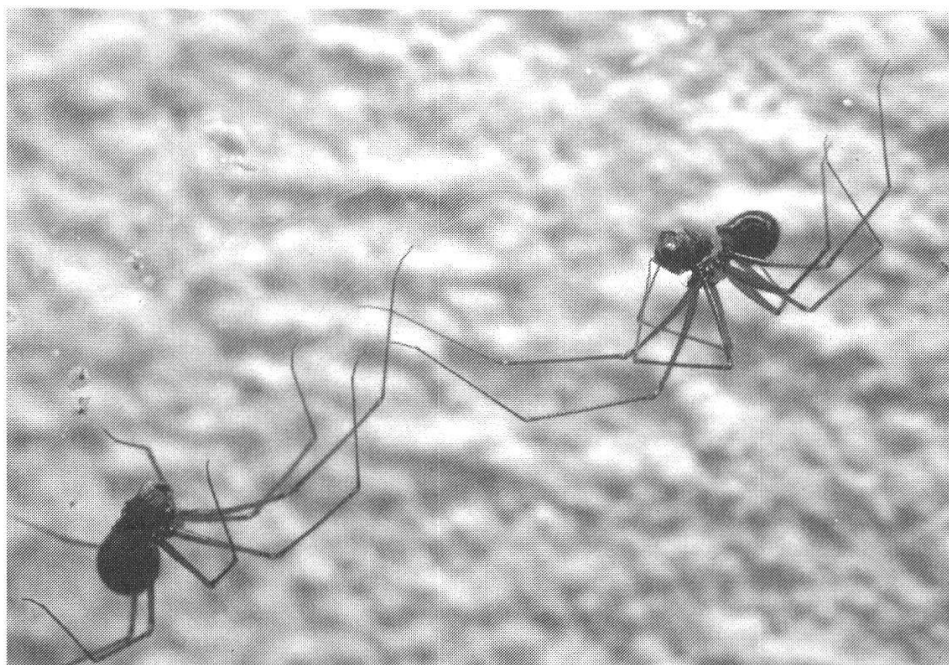


Fig. 1.-
Photographie
de *Psilochorus*
simoni dans
sa toile.
(Photographie
P.A. Fürst,
La fromagerie
des Jordans)

2. DISTRIBUTION EN SUISSE

En Suisse, la découverte de *P. simoni* incombe à COMELLINI (1954). Les exemplaires récoltés provenaient de 4 caves de la région genevoise (fig. 3). Les caractéristiques abiotiques des lieux de récoltes ne sont pas précisées dans son article.

Par la suite, il faut attendre juin 1985 (NEUENSCHWANDER & WESOLI; détermination P.A. Fürst) pour retrouver la trace de cette espèce. Une station a été découverte dans la buanderie, au sous-sol (sombre) d'une maison habitée, à Cortaillod près de Neuchâtel (alt. 475 m) (fig. 3). Selon les habitants, la température y est plus ou moins constante toute l'année, et l'humidité moyenne à forte.

Dans l'idée de mieux connaître les araignées des maisons, nous avons été amenés à prospecter des habitations dans la vallée de la Brévine (Canton de Neuchâtel) durant les printemps et étés 1990-1991. Cette vallée, située à 1000 m d'altitude, est caractérisée par des hivers extrêmement froids. Il est fréquent que la température descende au-dessous de -25°C. Dans trois fromageries (Les Jordans, 1056 m alt., Le Cerneux-Péquignot, 1088 m alt., La Chaux-du-Milieu, 1062 m alt.), nous avons trouvé des populations très importantes (n>100 individus) comprenant des mâles et des femelles, ainsi que tous les stades de développement de l'oeuf à l'adulte. Les populations se trouvaient dans les caves de maturation du fromage, endroits où les conditions climatiques sont toujours stables, toute l'année: humidité entre 98 % et 100 % (suintement sur les

murs et au sol), température entre 15°C et 17°C, et pas de lumière (à l'exception des périodes de travail).

Une autre station a été découverte en août 1991, au Locle, dans le Canton de Neuchâtel (alt. 916 m). Une petite population (10 individus environ) occupait les 50 premiers centimètres au-dessus du sol, dans un coin d'une cave à vin. Là aussi, la température varie peu durant l'année (13-18°C). L'humidité y est moyenne (50-70 % environ), et la luminosité très faible.

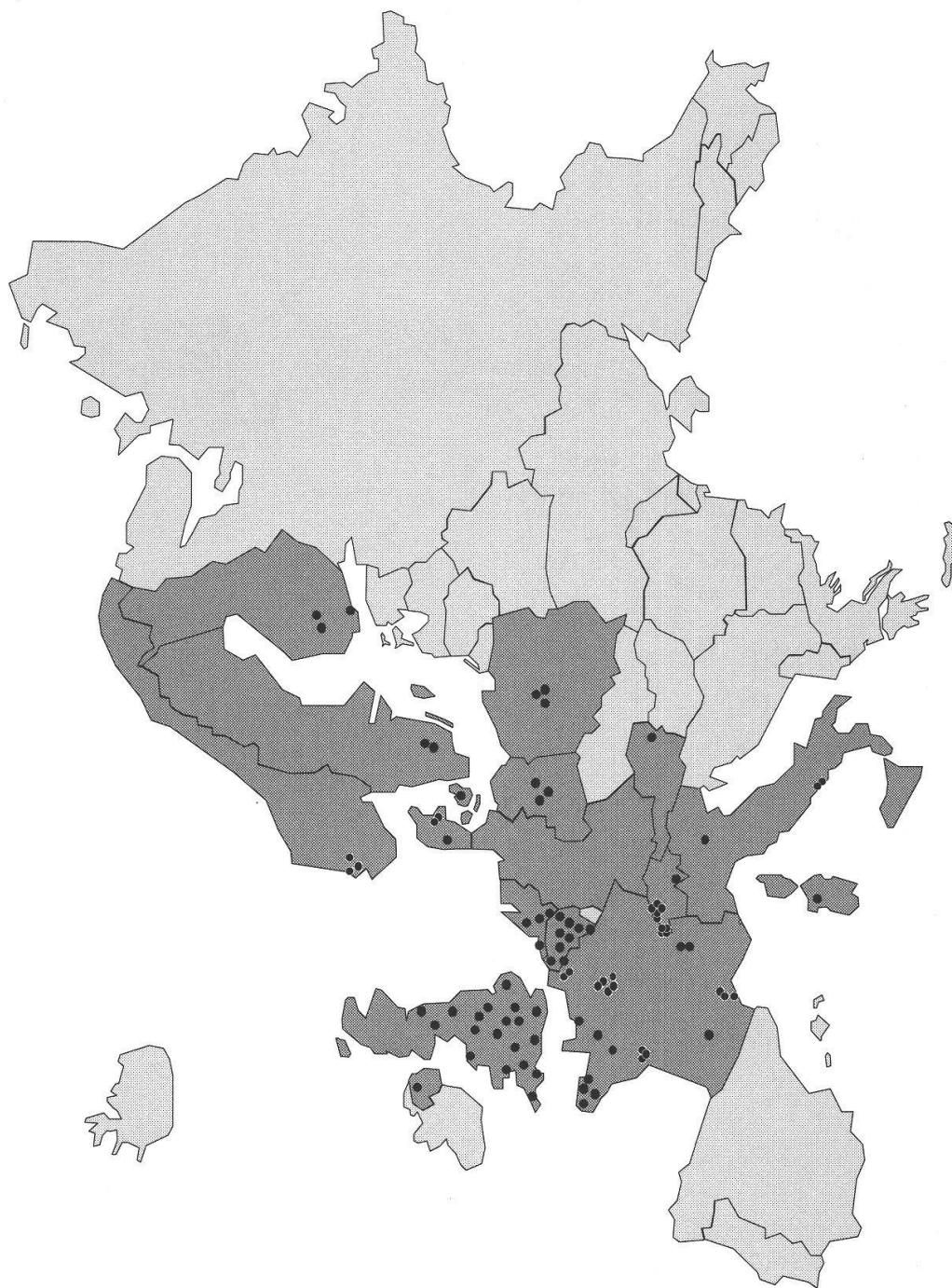


Fig. 2.- Distribution de *P. simoni* en Europe. La carte est essentiellement basée sur des données provenant de la littérature publiée. Chaque point équivaut à une station.

HÄNGGI (com. pers.) possède une curieuse référence dans le Canton du Tessin: 1 juvénile provenant d'une prairie maigre "moyennement sèche" (fig. 3).

La Suisse compte donc, actuellement, 9 stations connues de *Psilochorus simoni* (fig. 3), dans lesquelles des populations relativement grandes se sont développées et acclimatées.

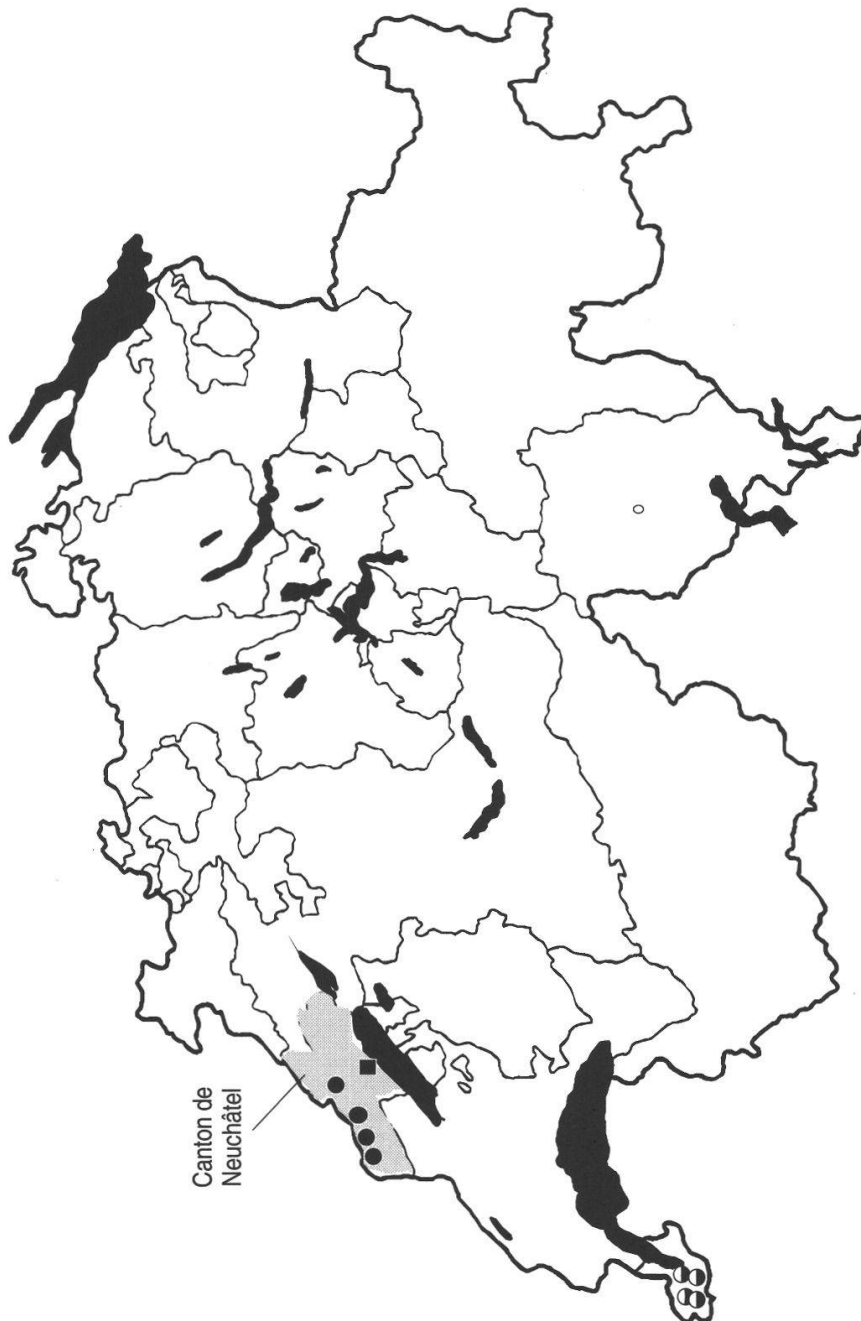


Fig. 3.- Distribution de *Psilochorus simoni* en Suisse.

- : 1954 Genève (COMELLINI)
- : 1985 Cortaillod (NEUENSCHWANDER & WESOLI)
- : 1989-90 Vallée de La Brévine (FÜRST & BLANDENIER)
- : 1988 Val Blenio (HÄNGGI)

3. AUTÉCOLOGIE DE *PSILOCHORUS SIMONI*

Dans un tableau synthétique (tab. 1), nous avons regroupé toutes les données concernant: température, humidité, lumière et situation des stations européennes. Les différents auteurs n'ont pas expressément mentionné tous ces renseignements, ce qui explique les nombres variables de cas pour un facteur donné (9 mentions de la température, 16 mentions concernant l'humidité, ...). Une analyse simple de ce tableau nous fournit les indications suivantes:

A) Température

Dans la grande majorité des données (6 sur 9) la température se situe entre 15°C et 18°C. VOSSENS (1983) signale que l'espèce disparaît lorsque la température descend au-dessous de 8°C. Beaucoup d'auteurs insistent sur le fait que *P. simoni* vit dans des endroits où la température est constante toute l'année. Aucun auteur ne mentionne des découvertes dans des stations où la température est supérieure à 18°C.

B) Humidité

L'espèce semble s'accomoder d'endroits aussi bien secs qu'humides, et ceci indépendamment de la latitude, contrairement aux renseignements trouvés dans JONES (édition française traduite et adaptée par EMERIT & LEDOUX, 1990).

C) Lumière

Les populations de *Psilochorus simoni* ont toujours été observées dans les endroits sombres (6 cas sur 6). Selon KLAUSEN (1972), plus on se rapproche des tubes néons, plus le nombre d'individus dimi-

"Factors"																		
Temperature				Humidity			Light		Locations "domestic"									
Category		Category		Category	Category	Category	Category	Category	Category	Category	Category	Category	Category	Category	Category	Category		
7-10 °C		11-14 °C		15-18 °C	Sec	Humide	Très Humide	Sombre	Lumineux	Caves	Caves fromages	Caves à vins	Subsols	Sous terrans	Abris atomiques	Appartements		
Grottes		Grottes		Patios														
1	2	6	7	4	5	6	0	14	5	3	3	1	1	5	1	1		
N=9				N=16			N=6		N=34									
n																		

Tab. 1.- Synthèse des facteurs abiotiques relevés dans les stations de *P. simoni*.

Données obtenues de la littérature sur un total de 45 stations européennes:

n=nombre de données pour chaque catégorie de facteurs

N=nombre de données pour chaque facteur pris en considération

nue. Dans une cave constamment éclairée, seuls les premiers décimètres au-dessus du sol sont colonisés, et ceci pour autant que des endroits sombres subsistent. Nos observations dans les caves à fromages vont également dans ce sens.

D) Lieux d'observation

Le tableau 1 met très nettement en évidence la préférence de cette espèce pour les "lieux domestiques" (32 cas sur 34), et plus spécialement les caves, sous-sols,... Au sens de VALESOVA-ZDARKOVA (1966), et pour l'Europe, nous pouvons qualifier cette espèce d'eusynanthrope.

E) Situations des toiles

P. simoni tisse une petite toile (9-25 cm² env.) accrochée à des supports divers: entre des planches de bois empilées (BRISTOWE, 1933), sous des bouteilles (KLAUSEN, 1972), ou dans les encadrements de portes (nos observations). En dernier ressort, elles utilisent un coin de mur.

Psilochorus simoni recherche donc les conditions idéales suivantes:

- >Températures constantes toute l'année.
- >Températures relativement basses (10-18 °C).
- >Lieux sombres.
- >Sa tolérance vis-à-vis de l'humidité est grande.

Ces conditions sont donc typiquement celles qui règneraient en milieu naturel dans les grottes.

A la vue de ces résultats, la référence tessinoise (unique donnée d'un milieu "naturel" ouvert) est certainement le résultat d'une contamination accidentelle dans des échantillons en provenance d'une prairie.

4. ZOOGEOGRAPHIE ET STATUT DE L'ESPECE

BERLAND, en 1911, a décrit cette espèce sous le nom de *Physocyclus simoni*. Ce genre comprend des espèces à répartition subtropicale et tropicale, essentiellement dans le Nouveau Monde. La plupart des auteurs ont donc mentionné une importation en Europe, à partir des zones tropicales.

En 1974 (LOCKET, MILLIDGE & MERRET), l'espèce est déplacée dans un autre genre: *Psilochorus*. Ce genre a certainement son origine dans une région comprise entre le sud des Etats-Unis et l'Amérique centrale. On y trouve 14 espèces décrites et 6 espèces non

décrites (com. pers. de CODDINGTON, selon ROTH, 1985). Le genre descend en tout cas jusqu'au Mexique et est essentiellement rencontré dans les grottes ou dans les maisons (espèces synanthropes).

Etant donné l'origine du genre, HEIMER & NENTWING (1991), comme beaucoup d'autres auteurs, concluent à une importation vraisemblable d'Amérique subtropicale. De plus, *P. simoni* est la seule espèce du genre habitant l'Ancien Monde...

Pour l'instant, mis à part GERTSCH (1979), qui mentionne *P. simoni* sur la côte californienne, aucune information n'a pu être récoltée sur l'autécologie et la distribution réelle de cette espèce sur le continent américain (com. pers. de CODDINGTON, LEVI, PLATNICK). Le nombre d'espèces appartenant au genre *Psilochorus* étant certainement encore plus important que celui annoncé par ROTH, une révision du genre serait nécessaire pour avoir des renseignements plus précis.

La figure 4 montre que la thèse d'une colonisation de l'Europe à partir de Paris, dès 1911, est très probable. Cette hypothèse est construite sur 3 principes théoriques qu'il conviendrait de nuancer, mais qui nous permettent tout de même de soutenir notre idée.

1. Le premier, et le principal (peut-être l'unique) point de départ en Europe est Paris (1911).
2. L'intensité du travail de prospection des arachnologues a été plus ou moins identique, partout en Europe.
3. La colonisation de nouveaux habitats se fait par l'intermédiaire de l'Homme, par les déplacements et les transports (BRISTOWE, 1933), et est de même intensité dans toutes les directions.

A partir de ces trois hypothèses, nous devrions donc montrer que plus on s'éloigne de Paris, plus les "premières" découvertes pour une zone donnée (bande circulaire) sont tardives. Dans l'ensemble, la figure 4 montre assez bien ce phénomène. On assisterait à une sorte de radiation, dont le centre serait Paris, qui confirmerait la thèse de l'importation. Cela signifierait aussi que l'espèce est en expansion en Europe.

Il faut toutefois tenir compte du fait suivant: une fois importée dans une région, l'espèce peut coloniser plus ou moins rapidement les milieux propices avoisinants. Ce phénomène que nous pourrions appeler "radiation locale" a été mis en évidence en Grande-Bretagne par MERRETT (1979). Cet auteur souligne également que cette espèce est en expansion dans ce pays depuis son importation datant de 1932. Les connaissances faunistiques des araignées de Grande-Bretagne sont certainement les plus complètes au monde. Elles permettent la confirmation de l'expansion réelle d'une espèce et non pas simplement une intensification des recherches arachnologiques, ceci d'autant plus que *P. simoni* est facilement identifiable, synanthrope et ne passe pas inaperçu.

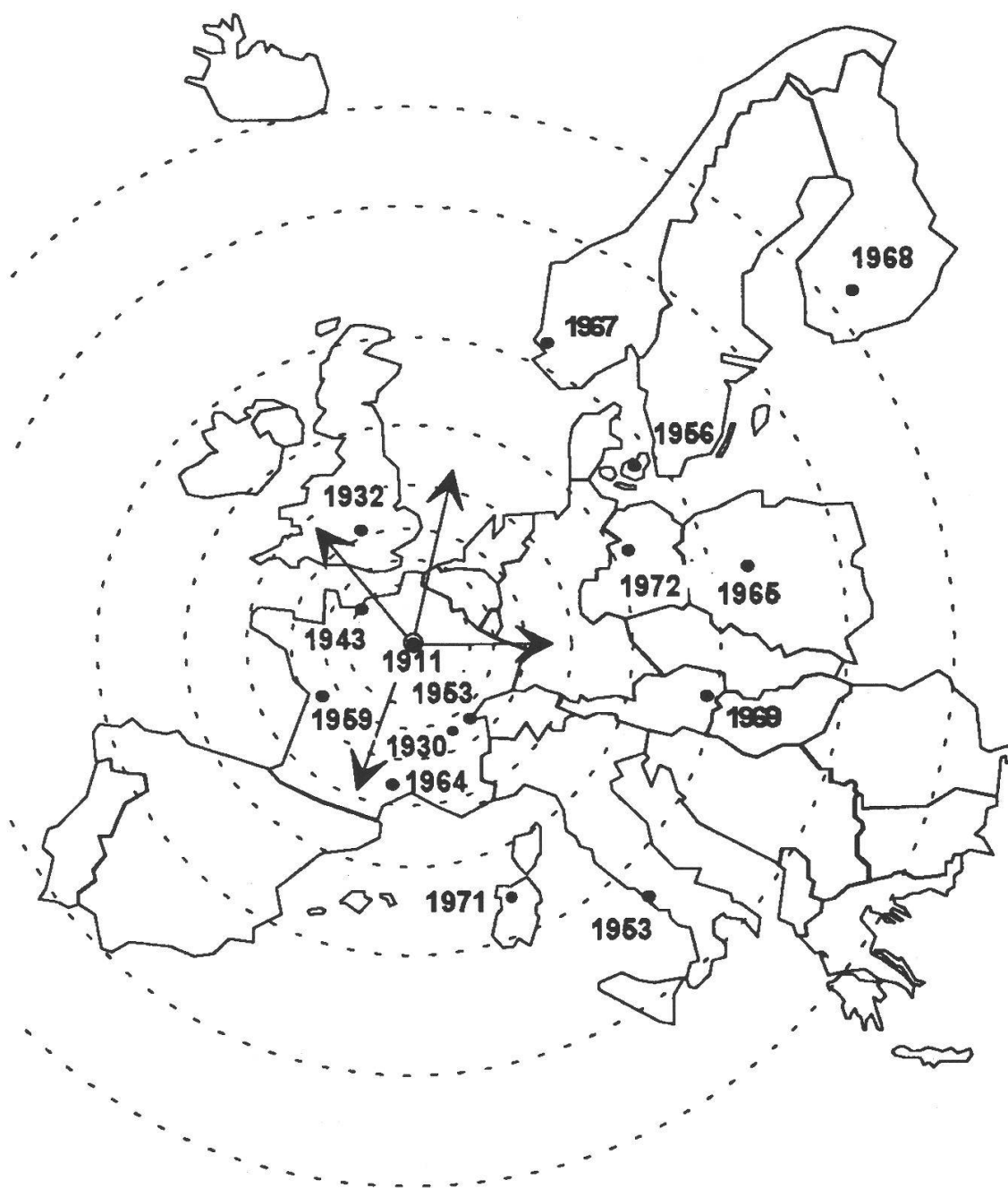


Fig. 4.- Hypothèse sur la colonisation de l'Europe à partir de Paris. Les différentes circonférences représentent la progression dans le temps.

5. CONCLUSION

Psilochorus simoni est une espèce très probablement importée d'Amérique en Europe au début du siècle. Transportée par l'Homme, elle y est en expansion. Il est également très probable que la majorité des stations européennes aient été colonisées à partir de Paris.

En Suisse en tout cas, une prospection plus attentive dans les endroits propices à son développement apporterait certainement de nouvelles données concernant sa distribution.

Remerciements: Nous aimerions remercier les propriétaires ou gérants des fromageries de la vallée de La Brévine pour leur accueil, et plus spécialement la fromagerie du Jordan que nous avons prospectée à plusieurs reprises. Nous remercions également J. Coddington, N. Platnick et H. Levi pour les renseignements qu'ils nous ont fournis concernant les données américaines.

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Proposed style for computer files of arachnological references.

par
Jonathan A. Coddington
Pierre-Alain Fürst

1. INTRODUCTION

In order to transfer information efficiently between different bibliographic databases, the database file structures must be compatible, e.g. record and fields. This system outlines a standard record structure that should be convenient for different organizations. This format is entirely compatible with "Spider literature: A computer bibliography, version 3.0 (CODDINGTON, 1991), and with the CIDA bibliography (DEMANGE, pers. com.)

Each record is composed by 15 fields: 9 devoted to bibliographic information, and 6 devoted to keyword information, + one (16) for record separator (*). Each field occupies one and only one logical line and each logical line is terminated by a hard carriage return. No carriage returns should occur within a field. Records (e.g. citations, bibliographic entries, references, hereafter referred to as "references") are separated by a separator "**". The symbol "<" symbolizes a hard carriage return, ASCII 10. The fields are listed below. Fields 1, 2, 4, 5 and 10 must be entered for a reference to be acceptable. The remaining fields can be left blank if the information is unknown. Explanations for each field, and real examples follow.

Please note that exact adherence to the following format is important. As long as files have uniform structure, it is relatively easy to change that structure with programs or with global search and replace commands. As soon as random variation from the set format appears, such a procedure introduces errors, and corrections take a long time.

2. FIELDS

REMEMBER: "<" SYMBOLISES A CARRIAGE RETURN (ASCII CODE 10)

Line number:	Field title:
(1)	AUTHOR(S)<
(2)	YEAR (NOMINAL)<
(3)	YEAR (ACTUAL)<
(4)	TITLE<
(5)	JOURNAL TITLE/REFERENCE<
(6)	VOLUME/SERIES NUMBER<
(7)	PART(FASCICLE)<
(8)	PAGINATION<
(9)	LANGUAGE OF ORIGINAL ARTICLE AND SUMMARY, IF DIFFERENT<
(10)	TOPIC<
(11)	BIOGEOGRAPHY<
(12)	COUNTRY<
(13)	HABITAT<
(14)	TAXONOMY<
(15)	MISCELLANEOUS<
(16)	*<

3. EXPLANATION OF FIELDS

Material within (" ") quotes is exactly as it should appear in the field:

1. AUTHOR(S). Authors of the references are listed in the following format:

```
first author, initials/second author, initials/third author, initials<
-----, -----/-----/-----<
```

In this format last names and initials strictly alternate. First, given, or Christian names are always abbreviated as initials, never spelled out. Last names that consist of more than one word, or one word with particles such as von, Van, de, de l', etc. are entered with the first word or particle of the name first.

Thus:

"van Helsdingen, PJ" or "di Caporiacco, L"

NOT: "Helsdingen, PJ van," or "Caporiacco, L di"

This name order should be followed, regardless of the style preferred in the person's native language or country, in order to maintain consistency internationally.

Initials are set off from last names by commas and no intervening spaces. Initials should consist only of capital alphabetic characters (no hyphens or lower case letters). The following four lines are correctly entered AUTHOR fields. Note that in correctly entered author fields, the number of commas is equal to the number of authors; the number of "/" (slash) is equal to the number of authors - 1.

e.g.

"d'Ajello,V/Mauro,A/Bettini,S<"

"de Armas,LF/Alay'n Garcia,G<"

"Deeleman-Reinhold,CL<"

"den Hollander,J/Dijkstra,HJ/Alleman,H/Vlijm,L<"

2. YEAR (NOMINAL). This is the year of publication printed on the reference, i.e. in the issue of the year, or on the title page of the book or monograph or whatever. Because the actual date of publication may differ from the nominal date, two fields are necessary to code this information. For example the last issue of a journal in a given year often is not printed and issued until early in the following calendar year.

3. YEAR (ACTUAL). This is the actual year of publication in which the reference appeared, if different from the nominal year of publication. When in doubt, leave this field blank.

4. TITLE. Titles should be entered exactly as they appear in the original publication, e.g. a direct quote. Do not break long titles into two lines with carriage returns. If titles contain underlined words such as latin names, code the start of the underline as "\$" (ASCII 036) and the end of the underline as "£" (ASCII 156), e.g. "\$Araneus£ \$diadematus£" or "\$Araneus diadematus£".

Include diacritical marks necessary for French, German, Italian, Portuguese, and Spanish (see section on Diacritical Marks below). If the reference consists only of an abstract or summary of a talk, insert "(Abstract)-" at the very beginning of the title (note the two spaces symbolised by"-", after the closing parenthesis).

(Abstract) Title< (Abstract) -----<

e.g.:

"(Abstract) Ecdysones in spiders<"

If the title has been translated from its original language, enclose in square brackets.

[Title]<
[-----]<

e.g.

"[Description of three species of spider
from Shaanxi Province, China]<"

5. REFERENCES/JOURNAL TITLE

5a. If published in a journal or series, put the journal or series title here. Abbreviations of words in the journal title are acceptable, but be sure to include enough information so that a professional reference librarian can find the periodical. If it is useful to include the city of publication, include that in parentheses, thus "Psyche (Cambridge)". Obviously styles of abbreviations differ, but no uniform system is widely used. It is more practical to allow abbreviation now and save disk space than to try to impose a standard abbreviation style.

Journal title<
-----<

e.g.

"J. Anim. Ecol.<"
"Envir. Entom.<"

5b. If the reference is a book, use the following style. No intervening space after ";" (semicolon).

Publisher;Place of Publication<
-----;-----<

e.g.

"Cambridge University Press;Cambridge"

ALWAYS one ";" (semicolon) in this case: a book.

5c. If published as a chapter in a book, or something that can be construed as a chapter in a book (e.g. conference proceedings, symposium volumes, etc.), list as:

In: Title of main work;Editor, initials/Editor, initials
(Ed.);Publisher;Place of Publication<

In:-----;-----,-----/-----,-----
(Ed.);-----;-----<

e.g.

"In: Spiders: Webs, Behavior, and Evolution;Shear,WA
(Ed.);Stanford Univ. Press;Stanford"

ALWAYS "In:" At the beginning, and three ";" (semicolon) in this case: references with In:

The same reference supposing with unknown place of publication:

"In: Spiders: Webs, Behavior, and Evolution;Shear,WA
(Ed.);Stanford Univ. Press;"

NOTE THE ";" AT THE END !!!

The same reference supposing with unknown publisher:

"In: Spiders: Webs, Behavior, and Evolution;Shear,WA
(Ed.);;Stanford"

NOTE THE «;;» (two times) !!!

5d. If the reference does not seem to fall within any of the above categories (i.e. journal, book, or "in" reference), use the following miscellany format:

Details of reference;Available from: where to obtain it<
-----;Available from:-----<

e.g.

"Published by the American Arachnological
Society;Available from: Dr. John Reiskind,Dept.
Zoology,University of Florida,Gainesville,FL 32611"

ALWAYS "Available from:" in this case: special reference.

6. VOLUME/SERIES NUMBER. Include here the volume or series number of the journal or series. If inapplicable (e.g., the reference is a book or an "in" reference), leave this field blank.

7. PART/FASCICLE. Include here the part or fascicle in which the reference appeared, e.g. in a journal issued quarterly, the fascicle number would be 1, 2, 3, or 4.

8. PAGINATION. Include here the first page number of the reference and the last page number of the reference, separated by one hyphen, e.g. 251-322, or 1-344 in the case of a book or series. If the reference occupies only a single page, include just that number.

9. LANGUAGE. If the citation is in a different language than the body of the reference (e.g. a translation of a Japanese, Chinese, or Russian title), enter the language of the original reference here. If the reference includes a summary or abstract in a different language than the body of the text, indicate that as: "Japanese, english summary."

10. TOPIC.

11. BIOGEOGRAPHY.

12. COUNTRY.

13. HABITAT.

14. TAXONOMY.

15. MISCELLANEOUS.



These 6 fields are reserved for **KEYWORDS**
see FÜRST & MULHAUSER, 1991 for details.

General note for keywords fields: Keywords are coded by numbers. In a field, a "," (comma) separate two keywords, without space!

For example, a paper concerning:

Thomisidae in applied ecology and conservation, in
Switzerland, in Alps pastures has to be coded as:

(10) "9,10<" (9 for applied ecology, 10 for conservation)

(11) "30,31<" (30 for palearctic, 31 for European)

(12) "155<" (155 for Switzerland)

(13) "143,1<" (143 for Pasture, 1 for mountains)

(14) "5103<" (5103 for Thomisidae)

(15) "Xysticus decidiosus,Xysticus gallicus,pest
control,Canton du Valais<"

(Numbers in brackets refer to field numbers and would not be entered in the file)

4. DIACRITICAL MARKS

Diacritical marks are punctuation marks like umlauts, grave or aigu accents, tildes, cedillas, etc., which inflect some languages. Because of the limited but disparate ways that computers represent these characters, only those inflected characters accessible through the IBM extended ASCII character set will be included, i.e. ASCII 128-165:

Ç ü é â ä å ç ê ë ì í î ï Ä Å É æ Æ ô ö ò û ù ÿ Ö Ü ç £ ¥ Þ Æ í ó ú ñ Ñ

5. EXAMPLES

Numbers in brackets “()” refer to field numbers and would not be entered in the file; **All other characters must be type on the keyboard exactly as they appear here below and save in ASCII files.** “<” symbolizes a hard carriage return.

- (1) Wang,YW/Zhu,CD<
- (2) 1982<
- (3) <
- (4) [Description of three species of spider from Shaanxi Province,China]<
- (5) J. Bethune Med. Univ.<
- (6) 8<
- (7) <
- (8) 44-45<
- (9) Chinese<
- (10) 1<
- (11) 30,35<
- (12) <
- (13) <
- (14) 620<
- (15) Description<
- (16) *<
- (1) Jackson,RR<
- (2) 1977<
- (3) 1978<
- (4) Comparative studies of \$Dictyna£ and \$Mallos£ (Araneae: Dictynidae).III.
Prey and predatory behavior<

- (5) Psyche (Cambridge)<
- (6) 84<
- (7) 3-4<
- (8) 267-280<
- (9) <
- (10) 11<
- (11) <
- (12) <
- (13) 5075<
- (14) <
- (15) Prey, Predator<
- (16) *<
- (1) Kovoov,J<
- (2) 1987<
- (3) <
- (4) Comparative structure and histochemistry of silk-producing organs
in arachnids<
- (5) In: Ecophysiology of Spiders;Nentwig,W (Ed.);Springer-Verlag;Berlin<
- (6) <
- (7) <
- (8) 160-186<
- (9) <
- (10) 5,6,7,20,24<
- (11) <
- (12) <
- (13) 11000,5000,4000<
- (14) <
- (15) Silk,Silk glands,Prosomal glands,Opisthosomal glands,Mites (Acarina)<
- (16) *<
- (1) Barrientos,JA/Bach,C/Gaju,M<
- (2) In press<
- (3) <
- (4) Sobre algunas arañas de la cuenca del Bembezar (Cordoba, España).
I.El genero Arctosa C.L. Koch (Araneae, Lycosidae)<
- (5) Misc. Zoologica (Barcelona)
- (6) <
- (7) <
- (8) <
- (9) <
- (10) 3<
- (11) 30,33<
- (12) <

- (13) <
- (14) 149<
- (15) <
- (16) *<
- (1) Rao,PRM/Kanaka Raju,A/Appa Rao,RV/Krishna Moorthy Rao,BH<
- (2) 1981<
- (3) <
- (4) Note on a new record of spider predators of \$Amuasca biguttula
biguttula Ishida, a serious pest on mesta from Andhra Pradesh<
- (5) Indian J. Agric. Sci.<
- (6) 51<
- (7) 3<
- (8) 203-204<
- (9) <
- (10) 9<
- (11) 40,41<
- (12) 140,143<
- (13) <
- (14) 702<
- (15) predator,Pest control,Amuasca buguttula<
- (16) *<
- (1) Peters,HM/Kovoor,J<
- (2) 1980<
- (3) <
- (4) Un complément à l'appareil séricigène des Uloboridae (Araneae):
Le paracribellum et ses glandes<
- (5) Zoomorphology<
- (6) 96<
- (7) <
- (8) 91-102<
- (9) <
- (10) 6,7<
- (11) <
- (12) <
- (13) 5052<
- (14) <
- (15) silk organ,Paracribellum,Glands<
- (16) *<
- (1) Aitchison,CW<
- (2) 1986<
- (3) <
- (4) The ecology of spiders under snow<

- (5) In: Proceedings of the Ninth International Congress of Arachnology
(Panama: 1983);Eberhard,WG/Lubin,YD/Robinson,BC (Eds.);DC,
Smithsonian Inst. Press;Washington<
- (6) <
- (7) <
- (8) 15-18<
- (9) <
- (10) 8<
- (11) <
- (12) <
- (13) 5000<
- (14) <
- (15) Snow,Spiders<
- (16) *

6. CONCLUSION

At this time, this computer files format has not been chosen yet by the CIDA, but it could become official if it's felt to be necessary for the members or for the general secretary. In any case, as it was asked by the CIDA assembly, it completes the first step of the keywords system that has been set up in Turku (FÜRST & MULHAUSER, 1991).

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Pierre-Alain Fürst

Ecoconseil
Rue Daniel- Jeanrichard 44

Notes on the spinning apparatus of the spiders *Hyptiotes paradoxus* C.L.K., 1834, and *Uloborus walckenaerius* Latr., 1806 (Araneae: Uloboridae)

par
Jaromir Hajer

Summary: The postembryonic development of the spinning organs in the spiders *Hyptiotes paradoxus* and *Uloborus walckenaerius* was studied. The spinning apparatus of the first instar nymph is formed by three pairs of segmented spinnerets with differentiated spigots and functioning glands attached to them. Cribellum and calamistrum are not present yet, but only primary colulus. Development of cribellum and calamistrum at the stage of 2nd instar nymph is always accompanied by a parallel development of the median spinnerets glands, that produce construction elements of capture threads.

1. INTRODUCTION

The postembryonic development and morphology of the spinning apparatus of spiders *Hyptiotes paradoxus* and *Uloborus walckenaerius* was studied. In addition to three pairs of spinnerets these spiders are equipped with a cribellum producing a secretion that covers those parts of the web which serve to catch the prey. This production is accomplished with the assistance of the calamistrum, an organ formed by a row of hairs on the metatarsus of the fourth pair of legs.

2. MATERIAL AND METHODS

Material was collected at localities with large populations, observed and bred under laboratory conditions. The stage, instar, fertilization and age were clearly defi-

nable. All these parameters are important for the evaluation of the postembryonic development of the spinning apparatus and its secretive ability.

3. RESULTS

The genera *Uloborus* and *Hyptiotes* carry eight types of silk glands: glandulae ampullaceae major and minor, gl. piriformes, gl. cribelli and gl. paracribelli (KOVOOR 1977; PETERS & KOVOOR 1980). The last named glands are connected with the segmented tubes on the surface of the median spinnerets. Similar glands and their outer segmented tubes develop likewise in Dictynidae (HAJER 1988).

The study on the development of spinning apparatus indicates close functional, as well as developmental, relations between median spinnerets, their glands and the cribellum. The larvae spinning apparatus develops as three pairs of non-segmented tubercles without an outer spigots (larvae do not move). For the first instar nymph, it is formed by three pairs of segmented spinnerets with differentiated spigots and functioning spinning glands attached to them. However, the cribellum, paracribellum, calamistrum as well as pseudocalamistrum (*Hyptiotes*) are not present yet. Instead of cribellum, a primary colulus is developed (figure 1).

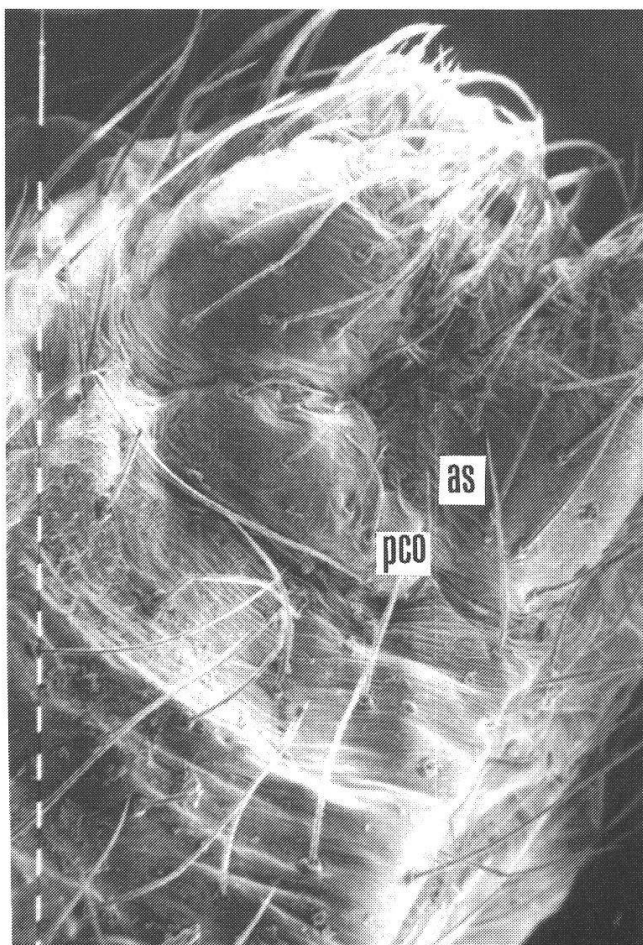


Fig. 1 -

The spinning apparatus of first instar nymphs is formed by three pairs segmented with differentiated spigots and functioning spinning glands. In the place of cribellum is primary colulus developed; **pco**-primary colulus, **as**-anterior spinneret.

Development of cribellum and calamistrum at 2nd instar stage nymphs is always accompanied by parallel development of the glands of median spinnerets that produce construction elements of capture threads.

The main developmental changes of the spinning apparatus in the ontogenesis of *Hyptiotes paradoxus* and *Uloborus walckenaerius*, expressed in quantitative factors, are shown in the tables I - II.

T A B L E I

The development of spinning apparatus during the ontogenesis of the spider *Hyptiotes paradoxus*.

Glands	S t a g e					adult.♂
	N.I	N.II	N.III.	N.IV.	adult.♀	
anterior spinnerets						
gl. ampullaceae major	2	1	1	1	1	1
gl. piriformes	6	8	22	38	71	36
Total for each spinneret	8	9	23	39	72	37
Total for both spinnerets	16	18	46	78	144	74
median spinnerets						
gl. ampullaceae minor	0	1	1	1	1	1
gl. tubuliformes	0	1	1	1	1	1
gl. aciniformes	4	6	12	17	28	19
gl. paracribelli	0	6	18	22	26	0
Total for each spinneret	4	15	33	42	57	20
Total for both spinnerets	8	30	66	84	114	40
posterior spinnerets						
gl. pseudoflagelliformes	0	1	1	1	1	0
gl. tubuliformes	-	-	-	-	-	4
gl. aciniformes	8	10	24	46	90	44
Total for each spinneret	8	11	25	47	95	44
Total for both spinnerets	16	22	50	94	190	88
Spinning apparatus total	40	70	162	256	448	202

T A B L E II

The spinning apparatus of the spider *Uloborus walckenaerius*.

Stage	Spinning glands	S p i n n e r e t s		
		anterior	median	posterior
adult females (adult males)	1. Gl. ampullaceae			
	a) major	1(1)	0(0)	0(0)
	b) minor	0(0)	1(1)	0(0)
	2. Gl. piriformes	73(42)	0(0)	0(0)
	3. Gl. aciniformes	0(0)	51(36)	108(62)
	4. Gl. tubuliformes	0(0)	2(2)	4(0)
	5. Gl. pseudoflagelliformes	0(0)	0(0)	1(0)
	6. Gl. paracribelli	0(0)	32(0)	0(0)
	Total for each spinneret	74(43)	86(39)	113(62)
N.II (I) Nymphal stages	Total for both spinnerets	148(86)	172(78)	226(124)
	Total for spinning apparatus	546 = adult female - cribellum present (288 = adult male) - without cribellum		
N.II (I) Nymphal stages	1. Gl. ampullaceae			
	a) major	1(2)	0(0)	0(0)
	b) minor	0(0)	1(0)	0(0)
	2. Gl. piriformes	8(6)	0(0)	0(0)
	3. Gl. aciniformes	0(0)	6(4)	19(14)
	4. Gl. tubuliformes	0(0)	2(0)	0(0)
	5. Gl. pseudoflagelliformes	0(0)	0(0)	1(0)
	6. Gl. paracribelli	0(0)	9(0)	0(0)
	Total for each spinneret	9(8)	18(4)	20(14)
	Total for both spinnerets	18(16)	36(8)	40(28)
	Total for spinning apparatus	94 = N.II - cribellum present (52 = N.I) - without cribellum		

The maximum development and capability of functioning of the spinning apparatus is achieved, for the females, after reaching sexual maturity.

In adult males, some parts of the spinning apparatus become reduced. Cribellum becomes obsolete as a functioning organ. The terminal part becomes sclerotized and it forms a compact whole. In comparison with others cribellate spiders (HAJER 1988), I have not found any hairs reminding of colular ones (excepting genus *Titanoeca*).

The reduction and functional changes of spinning apparatus are manifested in various degrees in the respective spinnerets. The most retained and longest functioning are anterior spinnerets and their glands (gl. ampullaceae and gl. piriformes), which produce drag lines and attachment discs.

The spinning ability of adult males is comparable with the 1st instar nymph. Their silk is primary ecribellate (N.I.) and secondary ecribellate (adult males), without any adhesive property.

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Minimale Flächengrösse zur Erhaltung standorttypischer Spinnengemeinschaften - Ergebnisse eines Vorversuches

par
Ambros Hänggi

Summary: In three localities pitfall traps, arranged in a transect line, were used to study the question: how far do spiders that live typically in the forest, penetrate into neighbouring habitats? According to these pilot experiments this distance is relatively short, i.e. below 10 m. The experimental set-up seems to be suitable for this kind of question, but should be improved by some specific adaptations (e.g. distance between traps).

1. EINLEITUNG

Die Landschaft des Kantons Tessin wurde noch bis vor ca. 30 Jahren wesentlich durch extensiv genutzte, sehr artenreiche Heuwiesen geprägt. Dabei handelt es sich vorwiegend um halbtrockene, kaum gedüngte Wiesen in Hanglage, mit meist nur 1 Schnitt pro Jahr. Heute ist dieser Lebensraum mehrfach gefährdet: wenn nicht Überbauung droht, so wird in flacheren Lagen die Landwirtschaft intensiviert, während in steileren Lagen die Nutzung ganz aufgegeben wird und die Flächen verbrachen. Da die traditionelle Nutzung landwirtschaftlich nicht attraktiv ist, scheint ein Schutz dieses Lebensraumtyps nur mit gezielten Pflegemassnahmen möglich zu sein. Aus Kostengründen ist deshalb ein Schutz in diesem Geländetyp kaum grossflächig möglich. Andererseits ist zu fragen, ob mit Kleinflächen wirklich jene Arten geschützt werden können, die für den entsprechenden Lebensraumtyp charakteristisch sind, oder ob nicht die lebensraumtypische Fauna weitgehend durch einstrahlende Arten aus Randbiotopen ersetzt wird. Alle Arten haben bestimmte Verteilungsmuster über die Lebensräume (vgl. Abbildung 1). So haben "Waldarten" den Verbreitungsschwerpunkt

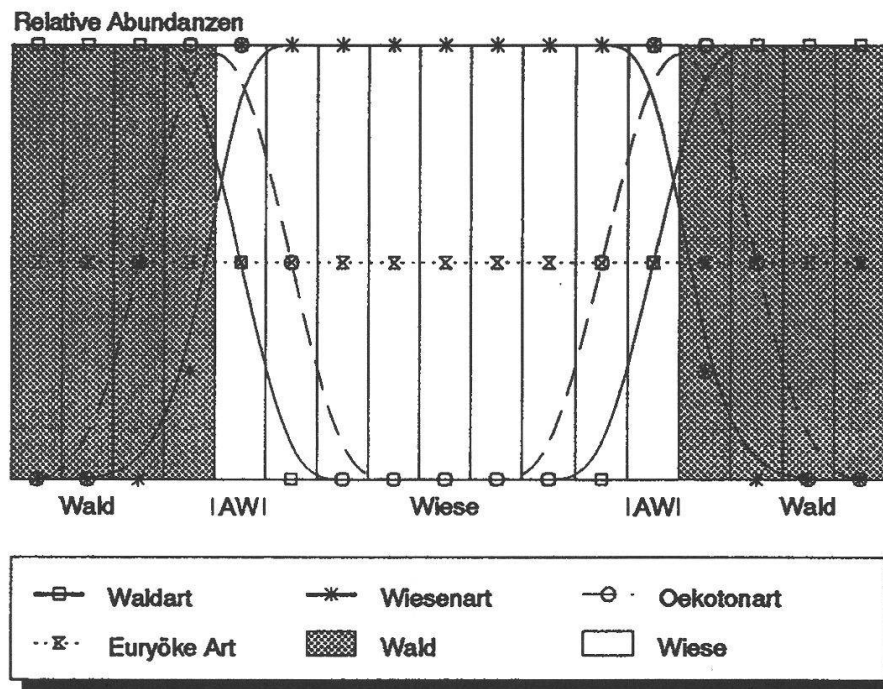


Abb. 1 - Hypothetische Verteilungsmuster der relativen Häufigkeiten von Arten entlang eines Transektes von Wald über Wiese in Wald.

im Wald, strahlen aber an den Waldrändern mehr oder weniger weit in andere Lebensraumtypen aus. Wenn der Bereich dieser Ausstrahlung bekannt wäre (Distanz AW in Abbildung 1), könnte man abschätzen, wie gross z.B. eine Heuwiesenfläche mindestens sein müsste ($>2 \times AW$), um im Zentrum, wenigstens theoretisch, eine ungestörte, standorttypische Fauna erwarten zu können.

2. METHODE

Im Rahmen des multidisziplinären Projektes "Magerwiesen und -weiden im Tessin" unter der Leitung von Herrn Prof. Dr. O. Hegg, Botanisches Institut Bern*, war es möglich, dieser Frage im Sinne eines Vorversuches nachzugehen. Mit Hilfe von einfachen Fallentransekten mit Barberfallen (Durchmesser 7 cm, Höhe 7 cm, Fangflüssigkeit 4 % Formalin, mit Entspannungsmittel, überdacht, Abstand der Fallen jeweils ca. 4 - 5 Meter) sollte an 3 Untersuchungsorten gezeigt werden, wie weit in die Magerwiesen hinein noch nennenswerte Randeinflüsse von Waldarten festgestellt werden können. Zur Auswertung war lediglich eine graphische Darstellung der Individuenzahlen pro Art entlang der Transekte vorgesehen. Für statistische Auswertungen müsste der Versuchsaufbau wesentlich aufwendiger gestaltet werden.

*mit finanzieller Unterstützung des Schweizerischen Nationalfonds, Projekt 3.047-0.87

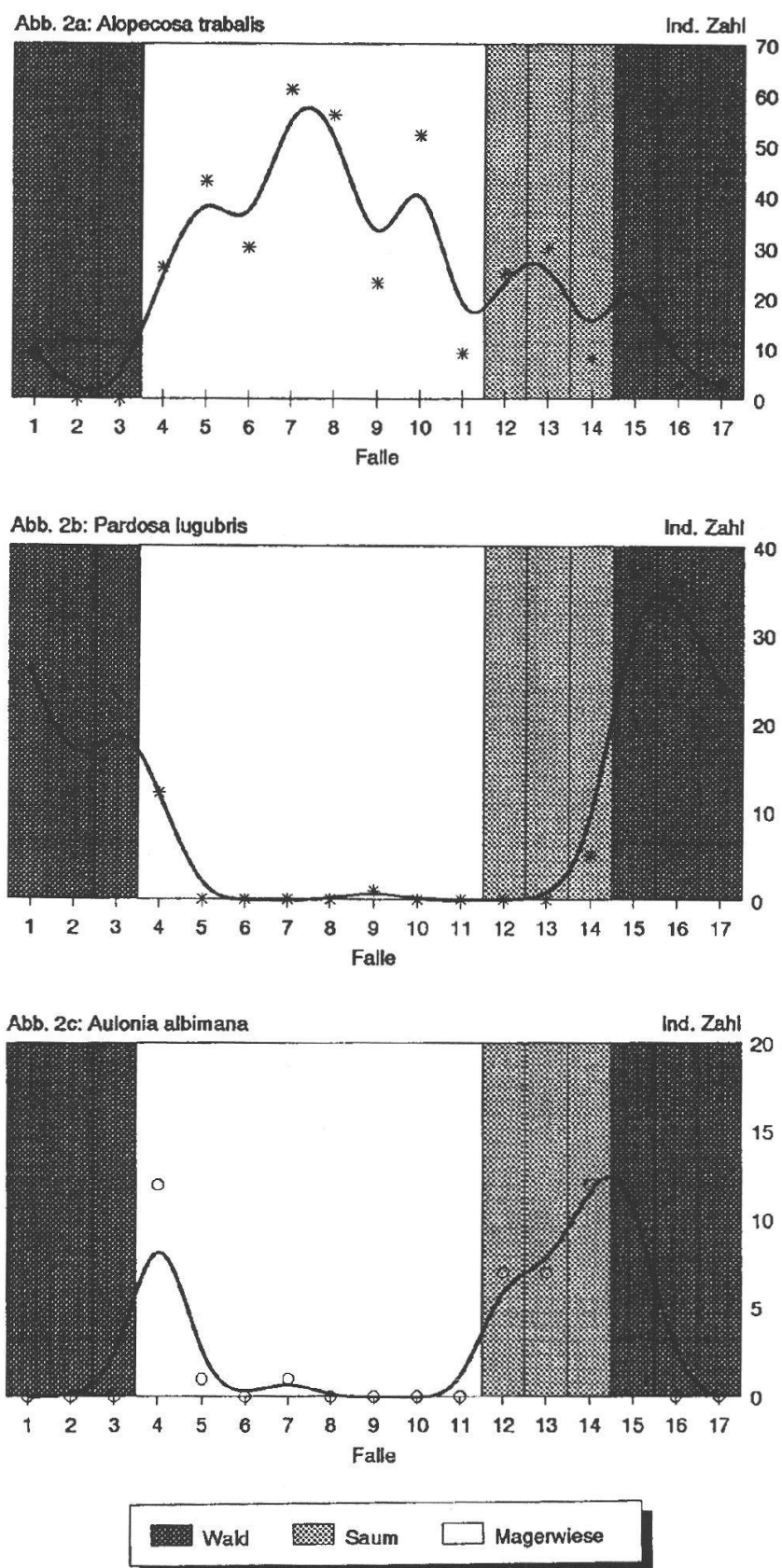


Abb. 2 - Verteilung der Individuenzahlen pro Falle einzelner Arten im Transekt Lionza (Centovalli).

3. RESULTATE

Für die Auswertung wurden nur jene Arten einbezogen, die in grösserer Zahl gefangen wurden und/oder bekannt sind für eine deutliche, stenöke Bindung an einen bestimmten Lebensraumtyp. Da die meisten Angaben bezüglich ökologischer Bindungen der Arten aus Arbeiten nördlich der Alpen stammen, wurde für diese provisorische Auswertung folgende Hilfsdefinition gewählt: eine Art wird dann als typisch für einen Lebensraumtyp bezeichnet, wenn mehr als 50 % aller in dieser Untersuchung gefangenen Individuen im betreffenden Lebensraumtyp festgestellt wurden (Basis: 42 Untersuchungsflächen).

3.1 Transekt Lionza, Centovalli (Abbildung 2, 4a)

17 Barberfallen, Fangzeitraum 1.5.89 - 12.11.89, Steilhang 25°, Fallen quer zum Hang, Exp. SE. Verteilung der Fallen: 1-3 in jungem (?) Wald auf ehemals vermutlich offenen Flächen, Waldrand unstrukturiert; 4-11 in offener Magerwiese; 12-14 im Saumbereich Wiese/Wald mit Zwergsträuchern; 15-17 in älterem Wald. Die Abbildung 2 zeigt die Individuenverteilung je einer Art entlang des Transektes (man beachte die unterschiedliche Skalierung der Y-Achse!). Die festgestellten Verteilungsmuster entsprechen sehr genau den theoretischen Erwartungen. Die Verteilung der Individuenzahlen von *Alopecosa trabalis* ist in Abbildung 2a dargestellt. Diese grosse Offenlandart dringt zwar in den Saumbereich ein, jedoch ist die Ausstrahlung in den Wald nur sehr gering. Die Waldart *Pardosa lugubris* (Abbildung 2b) strahlt nur wenig in den Wiesenbereich aus. Abbildung 2c zeigt die Individuenverteilung von *Aulonia albimana*, deren Vorkommen auf die beiden Übergangsbereiche konzentriert ist.

3.2 Transekt Pree, Mte. Generoso (Abbildung 3, 4b)

27 Barberfallen, Fangzeitraum 23.3.89 - 13.11.89, Hanglage durchschnittlich 15°, Fallen in Falllinie, Exp. S. Verteilung der Fallen: 1-3 in altem Wald, mit unstrukturisiertem Waldrand; 4-14 in einer Weide mit mosaikartiger Zusammensetzung zweier Vegetationstypen: Weide-dicht (Fallen 4, 5, 8, 9 und 12-14), mit dichter, von *Brachypodium pinnatum* dominierter Vegetation (dicke Streuschicht); Weide-offen (Fallen 6, 7 und 10, 11), mit kurzrasiger, z.T. lückiger Vegetation; 15-27 artenreiche Magerwiese (Trespenhalbtrockenrasen); Fallen 25-27 wie 15-27, aber an steil abfallendem Hang gegen Graben, im Einflussbereich des Schattens vom Gegenhang (v.a. Falle 27). Auf der anderen Seite des Grabens schliesst Wald an. Wiederum kommt je eine Art mit besonders typischer Verteilung der Individuen entlang des Transektes zur Darstellung. Die Magerwiesenart *Thanatus vulgaris* (Abbildung 3a) - es handelt sich dabei um die Form *atratus*, der von KRONESTEDT (1988) Artrang zugesprochen wurde - zeigt eine deutliche Präferenz für den Magerwiesenbereich, nicht nur im grossflächigen Teil, sondern auch in den kleinen, offenen Teilflächen der Weide. *Troglohyphantes caligatus* - von PESARINI (1989) beschrieben - muss aufgrund der Gesamtfänge als Waldart eingestuft werden, scheint aber bei geeigneten Strukturen

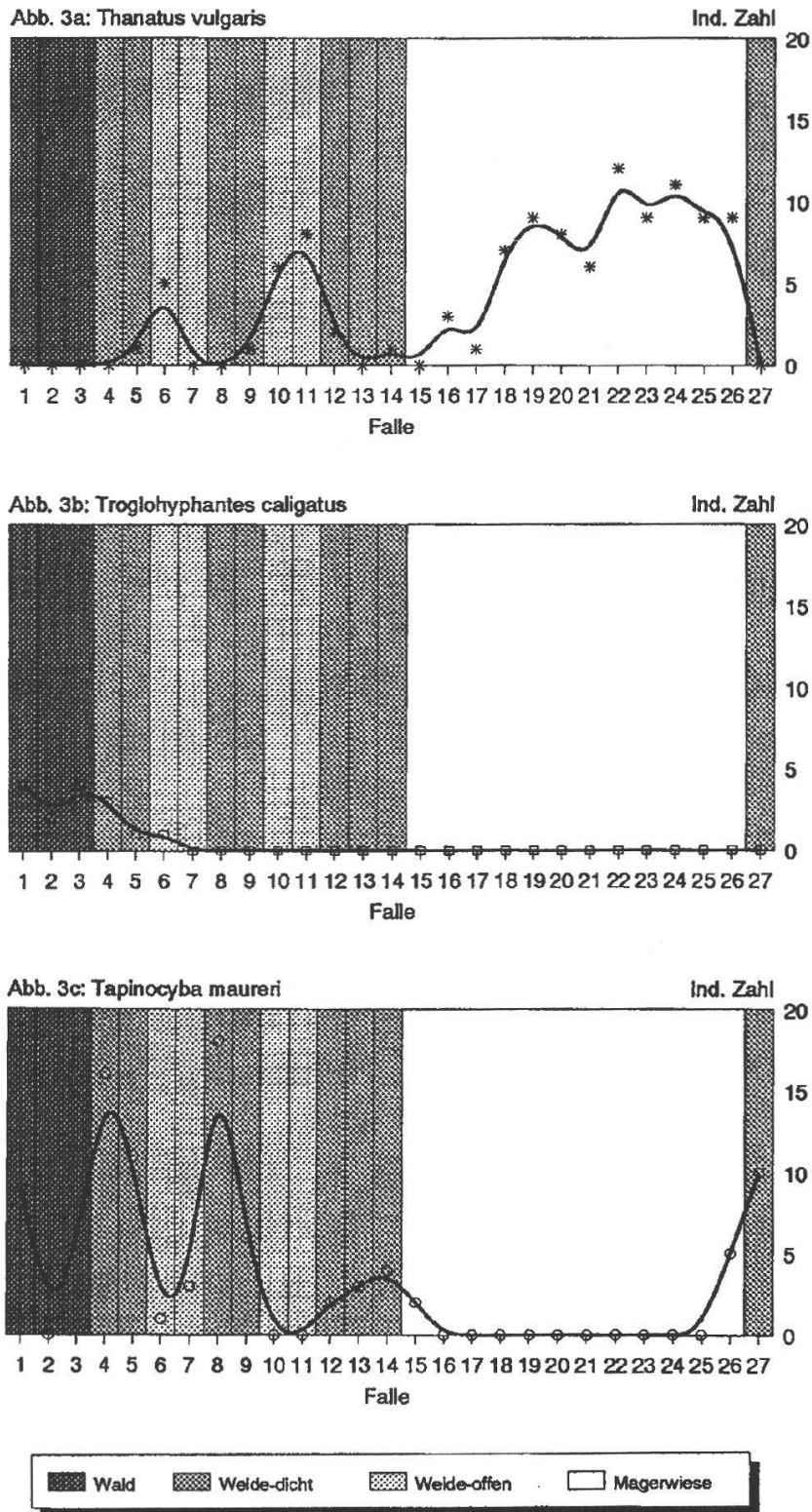


Abb. 3 -Verteilung der Individuenzahlen pro Falle einzelner Arten im Transekt Pree (Mte.Generoso).

(dichte Vegetation) recht weit auszustrahlen (Abbildung 3b). Im Transekt Lionza wurde mit *Aulonia albimana* eine Art der Übergangsbereiche vorgestellt. Hier wird nun eine Art dargestellt, die als Bracheart bezeichnet werden kann: *Tapinocyba maureri*, welche erst kürzlich von THALER (1991) beschrieben wurde (Abbildung 3c). Sie wurde regelmässig in Brachen festgestellt. Die Individuenverteilung in der Weide zeigt eine deutliche Bevorzugung der dichteren, bracheartigen Bestände.

4. DISKUSSION

In Abbildung 4 sind jeweils die summierten Individuenzahlen aller Waldarten der betreffenden Untersuchungsflächen dargestellt. Eine Ausstrahlung der Waldarten in benachbarte Lebensräume scheint im Gegensatz zu den Erwartungen nur bis zu relativ geringen Distanzen in grösserem Masse stattzufinden. Auch bei günstigen Bedingungen (Saumbereich in Lionza, Abbildung 4a; bracheartige Vegetation in der Weide Pree, Abbildung 4b) wird lediglich eine Ausstrahlung bis zur 2. Falle, also ca. 10 Meter, festgestellt (Einzelfänge sind über alle Lebensraumtypen jederzeit möglich!). Ebenfalls für relativ geringe Ausstrahlungen in andere Lebensraumtypen sprechen die sehr deutlichen Verteilungen der beiden Arten *T. vulgaris* und *T. maureri* in der Weide in Pree (Abbildung 3a, 3c), welche sich in der Individuenverteilung in den beiden Lebensräumen gegenseitig ergänzen (ohne vermutlich in direkter Konkurrenzsituation zu stehen, vgl. z.B. Grösse, Jagdstrategie).

Aus diesen Vorversuchen lassen sich noch keine gesicherten Ergebnisse ableiten. Immerhin zeigt sich, dass wahrscheinlich die Distanzen innerhalb welcher mit deutlichen Randeinflüssen in der Spinnenfauna zu rechnen ist, relativ klein sind. Dies steht in gewissem Widerspruch zu den Angaben von MADER (1981), der für Spinnengemeinschaften von Eichen-Hainbuchen-Wäldern Minimal-Flächen von ca. 10 ha verlangt (wobei die Situation bei Wäldern durchaus sehr verschieden von den hier untersuchten Magerwiesen sein kann!). Auch HEUBLEIN (1983) weist in 20 Meter Abstand vom Waldrand noch einen Waldartenanteil von 20 % mit ca. 15 % der Individuen nach. Zudem zeigt er rege Wanderungen ganzer Populationen im Randbereich auf. Andererseits stellen DEKEER et al. (1989) auch deutliche Unterschiede in der Verteilung der Arten in kleinsten Mosaikstrukturen (Bereich <1 m) fest, wobei dort auch tageszeitliche Kleinst-Wanderungen dokumentiert werden. Ebenfalls auf eine sehr kleinräumige Differenzierung der Artenzusammensetzung der Spinnenfauna weisen Transektfänge quer zu einem Flussschwallbänke hin (A. WOLF, pers. Mitt.). Zusammenfassend lässt sich festhalten, dass im Offenlandbereich wohl mit kleineren Distanzen zwischen den Fallen eines Transektes gearbeitet werden müsste, dass aber mit der transektmässigen Anordnung der Fallen, vor allem im Vergleich von Standorten mit klaren Grenzen und solchen mit mosaikartiger Struktur, sehr deutliche Angaben zur Einnischung der einzelnen Arten erhalten werden könnten.

Zusätzlich wäre bei entsprechend umfangreichen Fängen auch eine Auswertung bezü-

glich saisonaler Wanderungen möglich, was wiederum interessante Hinweise auf die Einnischung der Arten (evt. in mehrere Vegetationstypen gleichzeitig) geben könnte. Ein umfassender Versuch mit verfeinerter Methodik scheint lohnenswert.

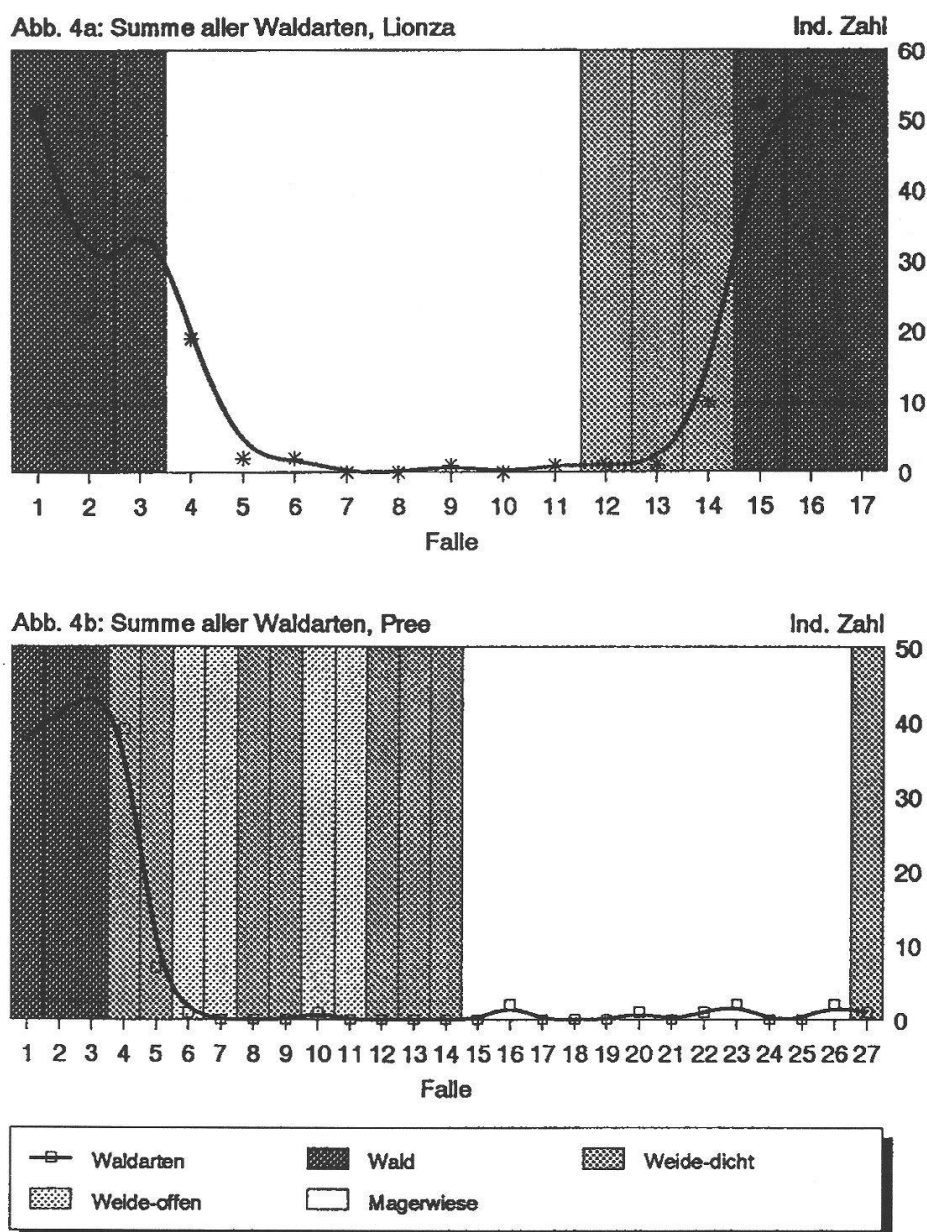


Abb. 4 -Pro Falle summierte Individuenzahlen aller Waldarten in den Transekten Lionza (4a) bzw. Pree (4b).

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Lebensdauer von mesothelen Spinnen

par
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Summary: Longevity of Mesothelae.

While most spiders have a reproductive cycle of about one year, primitive Araneae need at least three years to become adult. During the comparative study of morphology and ethology of Mesothelae, individual spiders were tested for their longevity. Heptathelid species (*Heptathela kimurai kimurai*, *H. k. amamiensis*, *H. k. yanbaruensis*, *Ryuthela nishihirai*) reach maturity after four to eight years with considerable individual variation. Although adult males die several weeks or up to three months after moulting for adulthood, females continue to live for up to 12 or even for 18 to 20 years.

The same range of longevity applies to *Liphistius batuensis*, *L. malayanus*, *L. desultor* and *L. murphyorum*..

The knowledge about longevity and reproduction rates proves to be useful in the assessment of ecological importance of Mesothelae.

1. EINLEITUNG

Durchforscht man die gängigen Lehrbücher der Biologie, wird man zur Frage von Altern und Tod -wenn überhaupt- nur sehr wenig Datenmaterial finden. Tierfreunde, die ihre Tiere in Gefangenschaft halten, interessieren sich schon eher für die Frage, wie lange wohl ein Terrarieninsasse gehalten werden kann, zumindest bei artgemäßer Haltung. Die Frage nach dem durchschnittlichen potentiellen Lebensalter kann jedoch auch von großem ökologischem Interesse sein.

2. LEBENSERWARTUNG EINHEIMISCHER WEBSPINNEN

Betrachten wir die einheimischen Webspinnen, so fällt auf, daß der wohl weitaus Überwiegende Teil der Arten in seiner Entwicklung einen Jahreszyklus aufweist (TRETZEL 1954; SCHAEFER 1987). Gerade bei ökologischen Untersuchungen zeigt sich, daß die Zeit der Geschlechtsreife bei den meisten Arten relativ eng auf eine bestimmte Jahreszeit begrenzt ist. Nach der Begattung und der Eiablage sterben die Spinnen innerhalb weniger Tage oder Wochen ab und überlassen das Feld ihrer Nachkommenschaft. Manche Kreuzspinnenarten bringen es allerdings auf zwei Überwinterungen (BRISTOWE 1958), und in nördlichen Regionen benötigen zumindest manche Webspinnenarten zwei Jahre um heranzuwachsen (TOFT 1976). Natürlich finden sich auch unter den entelegynen Spinnen Ausnahmen: so ist für *Lycosa narbonensis* ein Lebensalter von wenigstens vier, für *Filistata insidiatrix* von etwa 10 Jahren belegt, wobei letzterer Art nicht die Gelegenheit zur Fortpflanzung gegeben wurde (BERLAND 1932).

3. LEBENSERWARTUNG VON MYGALOMORPHEN

Etwas anders stellt sich die Situation bei den orthognathen Spinnen dar: Vogelspinnenfreunde wissen, daß in dieser Familie (Theraphosidae) gemeinhin allein drei Jahre benötigt werden, um überhaupt die Geschlechtsreife zu erlangen, drei weitere Jahre leben diese Tiere auf dem Höhepunkt ihrer Fortpflanzungsfähigkeit, dann setzt langsam aber sicher der Alterungsprozeß ein, der sich bis zu sechs oder mehr Jahren hinziehen kann (BÜCHERL 1962). In Einzelfällen wurden etwa 20 Lebensjahre erreicht.

Ein ähnliches Alter können auch Falltürspinnen der Familie Ctenizidae erreichen. Bereits adulte Vertreter der Gattungen *Latouchia* und *Ummidia* konnten wir zehn bis zwölf Jahre im Labor halten.

4. LEBENSERWARTUNG VON MESOTHELEN

Die jahrelangen Arbeiten an mesothelen Spinnen fern ihrer Vorkommensgebiete brachten es mit sich, daß sich einiges Material zur Altersstruktur dieser Tiere angesammelt hat.

Wenn wir einmal davon absehen, daß die Tiere in der Natur früher oder später die Beute von Predatoren, Parasiten oder Parasitoiden werden, ergibt sich bei isolierter Haltung in der Gefangenschaft die Möglichkeit, annähernd das potentielle Lebensalter zu bestimmen. Besonders gute Haltungs- und Zuchterfolge wurden hier bei Heptatheliden erzielt.

Das potentielle Lebensalter adulter Gliederspinnen unterscheidet sich natürlich grund-

sätzlich nach dem Geschlecht, denn die Männchen sterben wenige Wochen oder spätestens ca. drei Monate nach der Häutung zum Adultus, bis zu welchem Zeitpunkt dann bereits 4-8 Jahre verstrichen sein können (Abbildung 1). In der vorliegenden Graphik sind Todesfälle bei Jungspinnen und Häutungsunfälle unberücksichtigt geblieben.

Die Weibchen dagegen leben, ob begattet oder nicht, mehrere (im Schnitt 10) Jahre weiter, und ihr weiteres Wachstum kann bei einzelnen Arten anhand der säuberlich vor die Türklappe gelegten Exuvien genau verfolgt werden (HAUPT 1986). Zweifellos dürfte in Einzelfällen ein noch wesentlich höheres Alter erzielt werden, da man gelegentlich im Freiland deutlich größere Weibchen findet, und das Wachstum der adulten Tiere nur noch recht langsam voranschreitet.

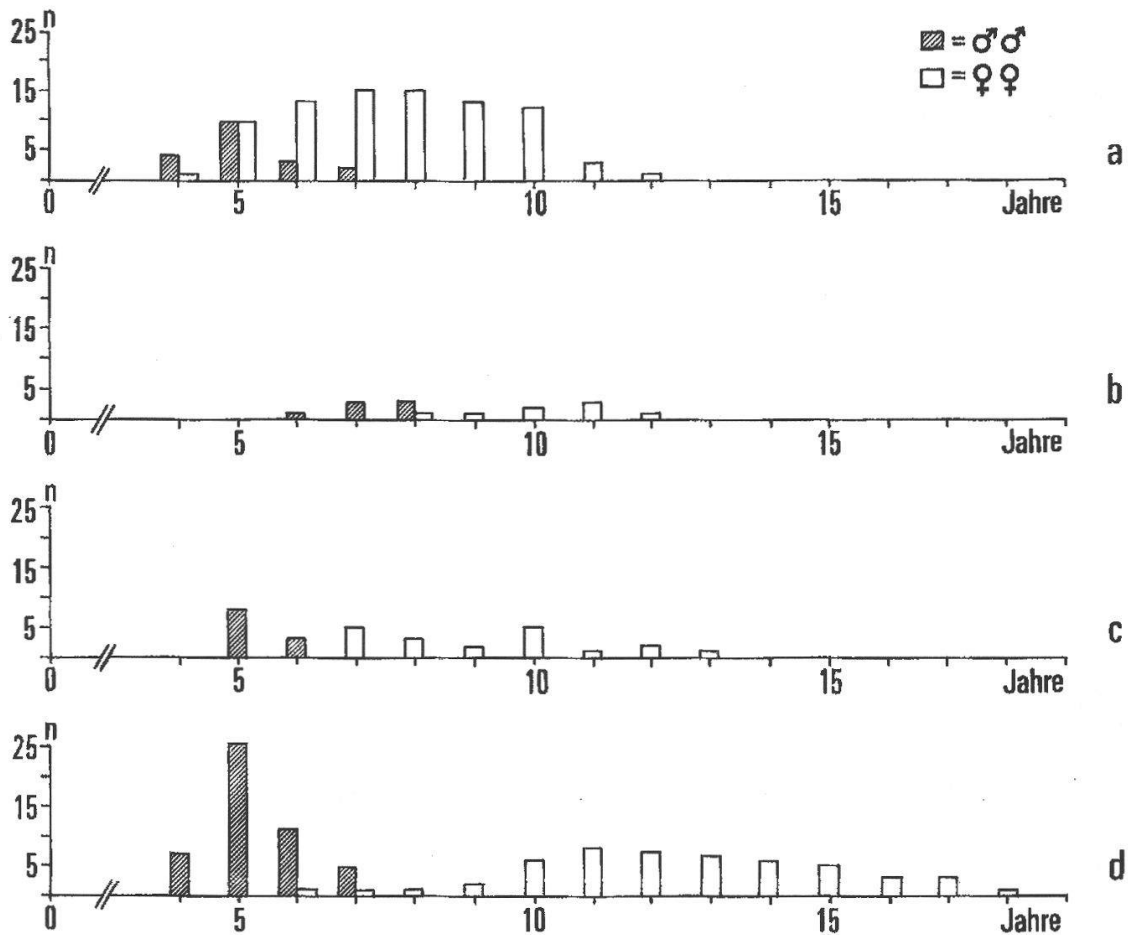


Fig. 1 - Anzahl (en) und erreichtes Lebensalter von Heptatheliden, aufgeschlüsselt nach dem Geschlecht.

- a) *Heptathela kimurai kimurai*
- b) *Heptathela kimurai amamiensis*
- c) *Heptathela kimurai yanbaruensis*
- d) *Ryuthela nishihirai*

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The gonosacs ('gonopods') of female pseudoscorpions (Arachnida, Chelonethi)

par
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Summary: The form and systematic distribution of the gonosacs ('gonopodes' Vachon) of the female genitalia of pseudoscorpions are reviewed. The new term 'gonosacs' is proposed for these organs in order to avoid confusion with the male gonopods of other arthropods. Gonosacs are present in all pseudoscorpion groups except the Chthonioidea. The form of the everted gonosacs is described and compared with that in the retracted state.

1. INTRODUCTION

Although authors such as VACHON (1938) and LEGG (1971) have added greatly to our knowledge of the functional anatomy of the genitalia of pseudoscorpions, some aspects are still problematic. One source of confusion is the 'gonopodes' of female Chelonethi. These eversible sacs were first described by VACHON (1938) who gives an excellent description of their role in the formation of the brood-sac in the cheliferid *Chelifer cancroides* (Linneus). He also recorded the presence of gonopodes in members of the Neobisiidae, and Chernetidae.

VACHON (1938) adopted the name '*gonopodes*' in accordance with his theory that the genital operculum (anterior genital sternite) is derived from fused opisthosomal appendages. This hypothesis, which is at best highly speculative, has been rejected by WEYGOLDT (1969) and LEGG (1974a). LEGG, however, continued to use the name gonopodium "on the grounds that it is an adequately descriptive term". A more important objection to its use is the possibility of confusion with the male gonopods of diplopods, spiders, ricinulei and mites. The name 'gonosacs' is therefore proposed here for the eversible sacs of female pseudoscorpions.

MAKIOKA (1970) described 'a temporary gonopodium' (actually paired gonosacs) in *Garypus japonicus* Beier (Garypidae). According to MAKIOKA, the gonosacs were only formed a few days prior to ovoposition, by extension and folding of the epithelium of the "anterior wall of [the] median chamber of the oviduct". They were rapidly retracted 10-11 days after ovoposition, after which the gonosacs slowly degenerated and finally disappeared. It is not clear from MAKIOKA's description that the gonosacs are cuticular and persist as internal, folded sacs when not extended. Only the tissues associated with functional gonosacs (muscles and vacuoles) are ephemeral.

Gonosacs have never been identified in illustrations of whole mounts of female genitalia, such as are used in taxonomic descriptions. This has often led to their being confused with spermathecae. The purpose of this note is to illustrate the gross morphology of the gonosacs in both their extended (functional) and retracted (non-functional) states.

2. METHODS

MAKIOKA (1970) found that ethanol-fixation of females with extended gonosacs resulted in the retraction of the gonosacs into the genital atrium. However, females preserved in alcohol are occasionally found with the gonosacs still protruding from the genital opening. The sacs are usually collapsed and could be mistaken for a brood sac without eggs. They can be returned to what is probably their natural state by clearing the specimen in lactic acid. If necessary, the turgidity of the sacs can be enhanced by transferring the cleared specimen to a weaker dilution of lactic acid.

3. MORPHOLOGY AND SYSTEMATIC DISTRIBUTION OF GONOSACS

3.1 Superfamily Chthonioidea

The Chthonioidea are the only pseudoscorpions without gonosacs. The lack of gonosacs in the Chthoniidae is probably correlated with the absence of a typical brood-sac (WEYGOLDT 1968). However, the Tridenchthoniidae, which seem also to lack gonosacs, are reported to form a normal brood-sac (WEYGOLDT 1968). Obviously, detailed observations of brood-sac formation in the Tridenchthoniidae would be of interest.

3.2 Superfamily Feaelloidea

The gonosacs of fealloids are large, paired and covered by numerous gland-pores (e.g. figure 1). Those of the Feallidae have been confused with spermathecae by HEURTAULT-ROSSI & JEZEQUEL (1965).

3.3 Superfamily Neobisioidea

The gonosacs of neobisioids are usually small, and often bear isolated pores on their surface. They have been described and figured as spermathecae (or seminal recep-

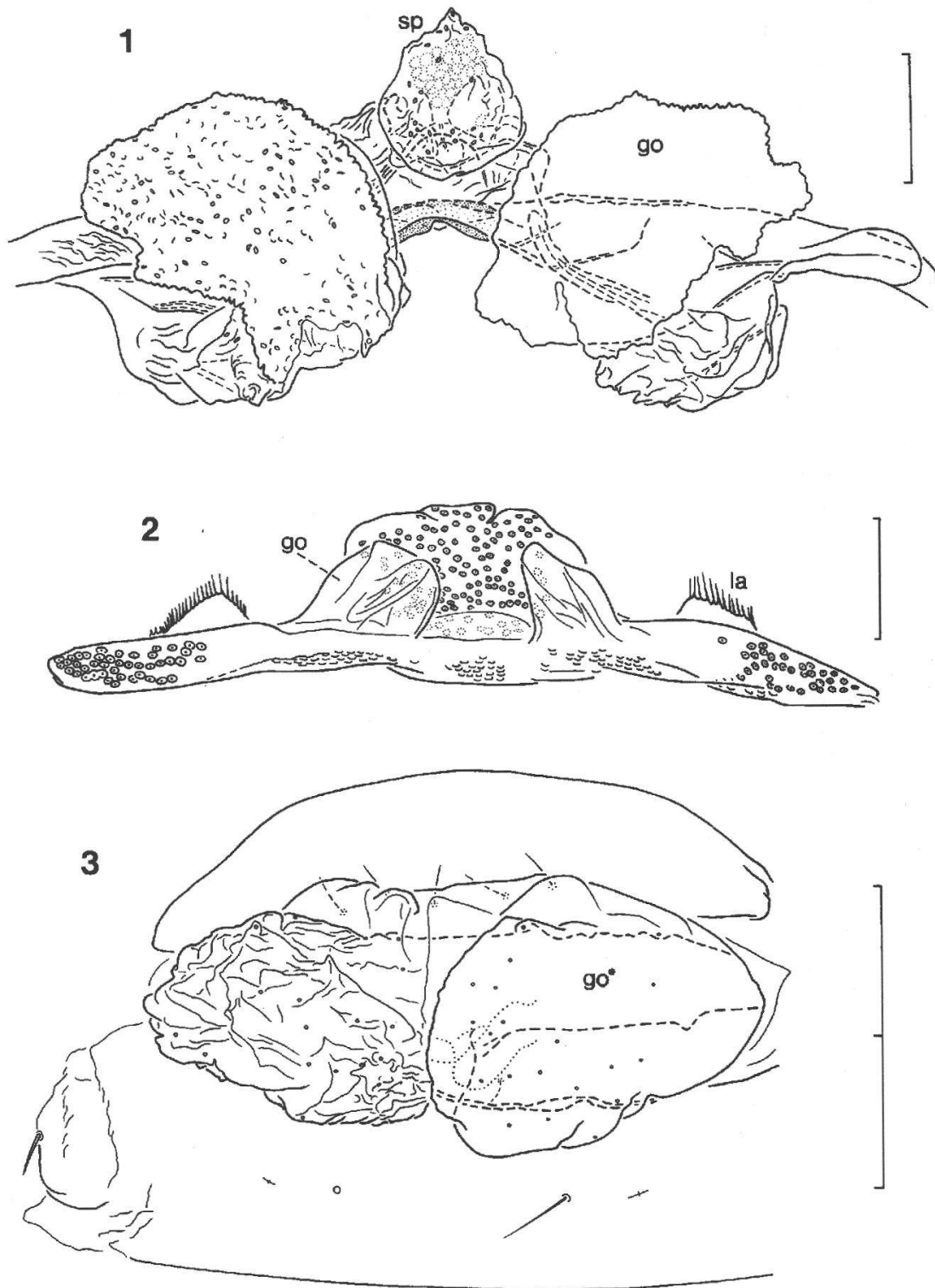


Fig. 1 - *Pseudogarypus banksi*, ventral view of internal genitalia of female.
Fig. 2 - *Neobisium carcinoides*, ventral view of internal genitalia of female.
Fig. 3 - *Negroroncus* sp. (Zimbabwe), ventral view of female genital area, with gonosacs everted.
 Abbreviations: **go** gonosac, **la** lateral apodeme, **sp** spermatheca. Scale line = 0.2mm (both figs. to same scale).

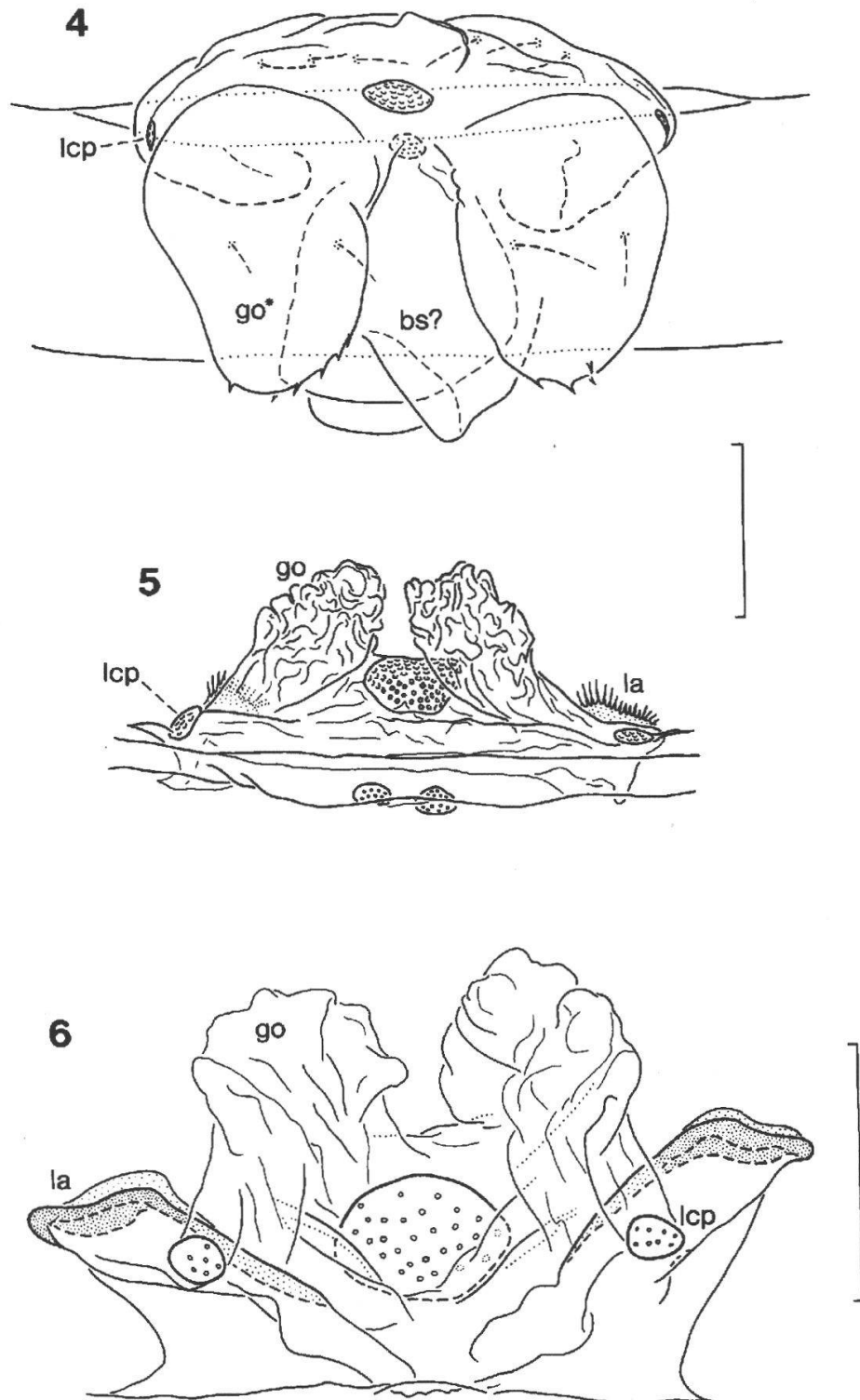


Fig. 4-5 - *Calocheiridius* sp., 3. ventral view of female genital area, with gonosacs everted, 4. ventral view of internal genitalia, with gonosacs retracted. Scale line = 0.1mm.
Fig. 6 - *Cryptocheiridium* sp., ventral view of female genitalia. Scale line = 0.05mm.
Abbreviations: **bs?** possible rudiment of brood sac, **go** gonosac, **la** lateral apodeme, **lcp** lateral cribriform plate.

tacles) in species of the families Hyidae (CHAMBERLIN 1946), Vachoniidae (CHAMBERLIN 1947, DUMITRESCO & ORGHIDAN 1977) and Bochicidae (MUCHMORE 1984). They are also present in the families Neobisiidae (e.g. figure 2), Gymnobisiidae and Syarinidae (pers. obs.). The gonosacs of the Ideoroncidae are relatively large and bear scattered pores on their surface (e.g. figure 3).

3.4 Superfamily Garypoidea

Gonosacs are present in the Garypidae (MAKIOKA 1968, 1970), Geogarypidae and Olpiidae (pers. obs.). They do not bear any pores on their surface.

The extended gonosacs of a gravid female of *Calocheiridius* sp. (Olpiidae) from Cameroon are shown in figure 4. They are confluent with the cuticle of the genital atrium, which is itself partly everted. Small, sharp spines are present on the posterior face of the gonosacs. The lateral cribriform plates, which secrete the brood sac (VACHON 1938), lie near the base of the sacs. Between them is a third, folded, slightly thicker 'sac' which may be a partially-formed brood sac. By comparison, the strongly folded form of the retracted gonosacs can be seen in figure 5. The spines on the surface of the gonosacs are not visible when the sacs are retracted.

3.5 Superfamily Cheiridioidea

CHAMBERLIN (1931), LEGG (1974b), BENEDICT (1978) and DUMITRESCO & ORGHIDAN (1981) have all confused the gonosacs of Cheiridiidae with spermathecae or 'spermathecal pockets'. The gonosacs of the Cheiridiidae (e.g. figure 6), Pycnocheiridiinae and Pseudochiridiidae all lack glandular pores.

3.6 Superfamily Cheliferoidea

The gonosacs of Cheliferidae, Withiidae and Atemnidae the gonosacs are large and strongly folded; those of the Chernetidae appear to be rather smaller. WEYGOLDT (1966, 1969) illustrated the everted gonosacs of the chernetid *Pselaphochernes scorpoides* (Hermann), which he called 'erectile bodies' (Schwellkörpern).

Figures of retracted chernetid gonosacs are provided by DUMITRESCO & ORGHIDAN (1977), though they are not labelled as such. The gonosacs of cheliferids of the tribe Dactylocheliferini have sometimes been mistaken for spermathecae (e.g. CHAMBERLIN 1949). The spermathecae illustrated by MUCHMORE (1973) in *Mexichelifer reddelli* Muchmore might also be gonosacs. JUDSON (1990), aware of the possible confusion between spermathecae and gonosacs, referred to the gonosacs of *Ellingsenius fulleri* (Hewitt & Godfrey) as 'membraneous sacs'.

The everted gonosacs of a *Micratemnus*(?) sp. (Atemnidae) from Cameroon (Chuboh, Bamenda Highlands) are shown in figures 7-8. These bear small spines on their posterior surface, similar to those of *Calocheiridius*. The spermatheca remains internal, opening between the bases of the gonosacs.

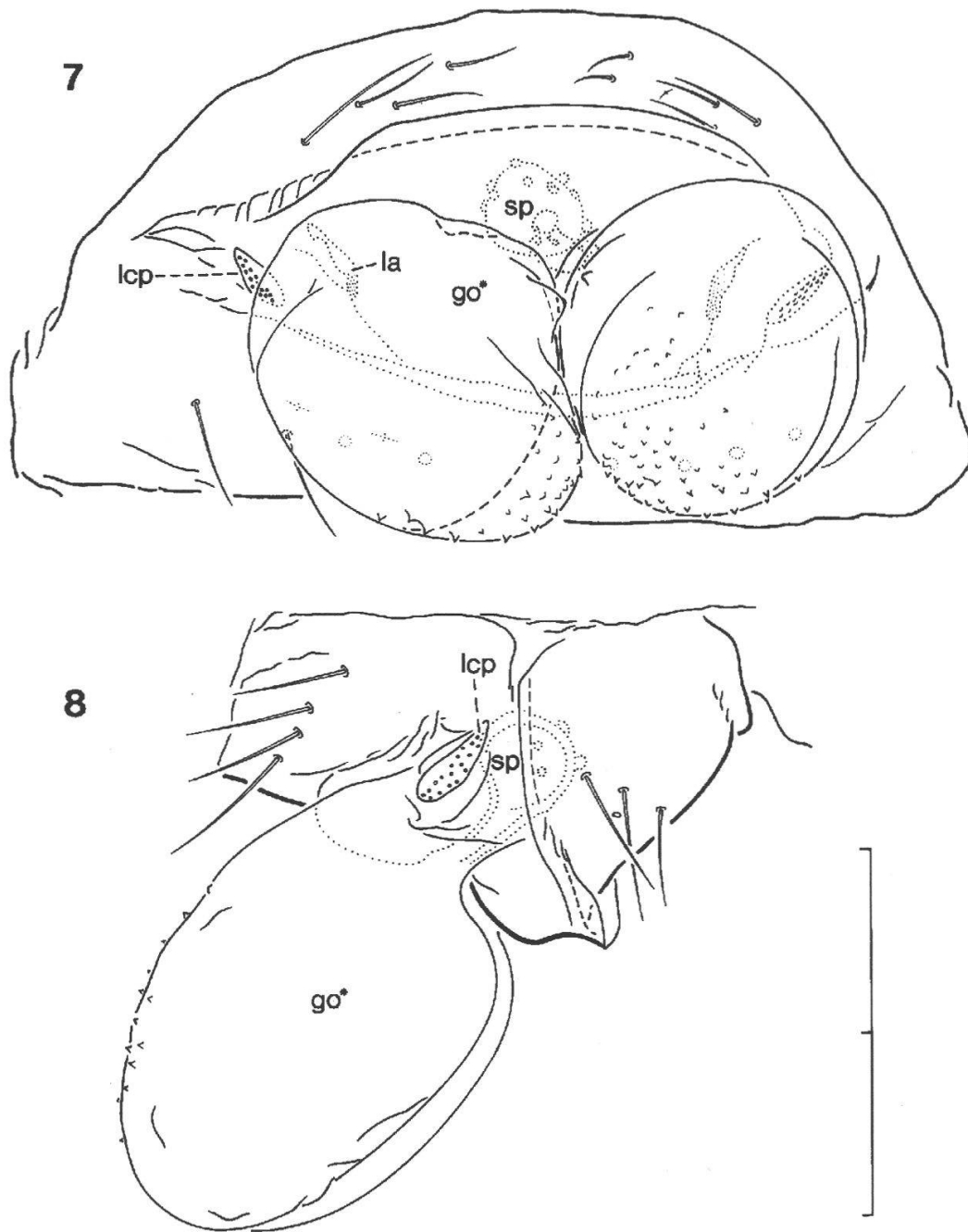


Fig. 7-8 - *Micratemnus(?)* sp.(Cameroon), 5, ventral and 6, lateral (anterior at right) views of female genital area with gonosacs everted.

Abbreviations: **ago** anterior genital sternite, **go** gonosac, **la** lateral apodeme, **lcp** lateral cribriform plate, **mcp** median cribriform plate, **pgo** posterior genital sternite, **r** folded ridge of anterior genital operculum, **sp** spermatheca.

4. DISCUSSION

Retracted gonosacs can be distinguished from spermathecae by their thinner, highly-folded cuticle and by having broad openings into the genital atrium. Identification of the the gonosacs as a constant feature of the female genitalia removes much of the confusion concerning the systematic distribution of spermathecae in Chelonethi. Gonosacs are present in all pseudoscorpions with the exception of the Chthonioidea. Because Feaelloidea (the sister-group of the Chthonioidea) possess gonosacs, we can assume that their absence in the Chthonioidea is due to secondary loss. Similar 'gonopods' are present in the females of Amblypygi (WEYGOLDT et al. 1972) and there is the intriguing possibility that these might be homologous with the gonosacs of pseudoscorpions.

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Long-term changes in spider communities of drained fens

par
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1. INTRODUCTION

The paper characterizes changes in spider communities in the peatland of Biebrza valley (22°30'–23°60') after 25 years. The study was carried out in 1955 in wet, extensively utilized natural grasslands and in managed drained parts of fen. The investigations were repeated in 1979–1980. Over the 25 years, the drained area has largely been extended. Large parts of wasteland and woods have disappeared. The valley has been covered with vast managed grassland. All managed grasslands (old and actual) have been drained in a similar way by ditches of the same depth, soil surface has been levelled by ploughing and rolling, and all of them were sown with a mixture of grasses with addition of clover. Although the grasslands were situated on soils developed from two types of peats, alderswamp peat or tall sedge peat, natural grasslands were much more differentiated, than managed ones (table I). Therefore, the material from managed grasslands is most suitable for comparisons.

Table 1. Characteristics of studied grassland sites

Grasslands										
Sites	Natural				Managed					
	old		actual		old		actual			
	1	2	3	4	5	6	7	8	9	10
Peat origin	ud	A	TS	TS	A	A	TS	TS	TS	A
Patch ≤ 2 ha	+					+	+	+	+	+
Size < 20 ha		+	+	+	+				+	+
Size > 20 ha										
Environmental stress: water level	sw	sw	fl	fl	-	-	-	-	-	-
Number of mowings	1	1	1	0-1	2	2	2	3	3	3
Number of plant species	ud	25	12	24	ud	10	29	30	43	ud

ud - undetermined, A - alder fen peat, TS - tall sedge, sw - standing water above ground level, fl - flooded

2. METHODS

The comparison of spider species composition was based on materials collected using a quadrat method. This technique was improved with time. The sample size was reduced from 0.25 m^2 to 0.065 m^2 . In 1955 spiders were collected by hand, whereas in the recent study, samples of the turf were cut out, and the spiders were shaken out of them onto a plastic sheet. In addition, all vegetation was carefully searched for spiders. This procedure increased the accuracy of density estimates, but the frequency of sampling was reduced, as well as the size of the sampled area.

Sampling was performed from May to November, every week in 1955 and once a month in later investigations. In 1979 and 1980 pitfall trapping was done 2-3 days every month. 10 pitfalls were placed in each site.

Because of differences in the sampling technique, it is difficult to estimate changes in the density of spiders, and it is also difficult to analyse detail changes in the composition of uncommon species. Thus, the comparison is limited to the composition of families and to the species abundance, at least at one site. The Shannon index of species diversity (H') was analysed in comparisons also.

3. RESULTS

Significant differences occurred between natural and managed sites of former grasslands with respect to the proportion of particular families (table II). The most abundant families in natural grasslands were Lycosidae (about 30% of individuals caught),

Araneidae, Thomisidae, and Linyphiidae. The most abundant families in the managed grasslands were Tetragnathidae (about 30% of the spiders). The proportion of Linyphiidae was higher and Lycosidae markedly lower than in natural sites, whereas the proportion of Araneidae had not changed.

Table 2. Family composition in natural (N) and managed (M) grasslands (per cent)

Sites	N Old		M Old		M Actual			
	1	2	5	6	7	8	9	10
Linyphiidae	11.6	13.0	18.2	24.5	50.4	56.5	73.0	66.3
Tetragnathidae	4.4	2.1	39.8	32.2	20.7	21.7	18.1	23.0
Lycosidae	29.2	37.0	6.6	9.2	25.2	19.1	6.9	7.3
Total: Li+Te+Ly	45.2	52.1	64.6	65.9	96.3	97.3	98.0	96.6
Thomisidae	14.8	11.7	5.0	8.9	2.5	0.9	1.8	1.9
Araneidae	22.0	11.5	24.1	14.9	-	-	-	-
Salticidae	3.8	4.1	0.4	0.4	-	0.9	-	-
Others	14.2	20.6	5.9	9.9	1.2	0.9	0.2	0.5

Formerly grasslands, both natural and managed, supported a high proportion of species permanently associated with the field layer. This was the case of the species either constructing webs in the field layer, laying egg sacs, or building shelters in this layer. Now the field layer is searched by epigean species only. The species characteristic of the field layer, exclusively associated with it, totally disappeared. The most important change is the complete lack of the family Araneidae. Not even single individuals were recorded in any of the grasslands, including both natural and managed. Earlier two species of this family, *Araneus quadratus* and *Singa pygmaea*, predominated on both the managed, mown grasslands and the natural ones. Another abundant species that totally disappeared is *Tibellus maritimus*.

In the actual managed grasslands, a further increase in the importance of Linyphiidae is observed. This family accounts for 50–73% of the spiders recorded from each site. The dominant species in all habitats are *Erigone atra* (17–26%) and *Dicymbium nigrum* (5–20%). In some sites, *Oedothorax fuscus*, *Oe. retusus* and *Centromerita bicolor* predominate as well. In former grasslands the most abundant species in that family were. *Meioneta rurestris*, *Linyphia pusilla* and *Dicymbium nigrum* (table III). Changes in the family Lycosidae are reflected in the dominant position of *Pardosa palustris*. Earlier on managed meadows this species was outnumbered by *Pardosa pullata* and *Trochosa spinipalpis*. In sum, the bulk of the spiders occurring in the grasslands is now represented by three families: Linyphiidae, Lycosidae, and Tetragnathidae. Earlier they accounted for not much more than 60% of the total number of spiders (table II).

The disappearing species have not been replaced by other species. This is indicated by a significant reduction of the indices of species diversity in the actual managed grasslands as compared with former ones (table IV).

Table 3. Composition of abundant species in per cent

Managed grasslands						
Sites	Old		Actual			
	5	6	7	8	9	10
<i>Araneus quadratus</i>	20.5	9.80	-	-	-	-
<i>Singa pygmaea</i>	2.8	3.0	-	-	-	-
<i>Meionetha rurestris</i>	3.9	5.8	-	-	1.4	3.8
<i>Linyphia pusilla</i>	5.3	3.4	-	-	-	-
<i>Centromerita biocolor</i>	1.9	1.3	7.9	2.6	2.5	2.9
<i>Dicymbium nigrum</i>	0.9	2.3	10.4	5.2	20.0	9.6
<i>Erigone atra</i>	0.2	-	16.8	26.0	19.2	26.0
<i>Pardosa palustris</i>	0.7	-	21.3	15.6	5.1	3.8
<i>Pachygnatha degeeri</i>	31.9	20.75	10.0	14.8	14.9	17.3
<i>P. degeeri</i> + <i>E. atra</i> + <i>D. nigrum</i> + <i>P. palustris</i>	33.7	23.05	58.5	61.6	59.2	62.2

Plate 4. Diversity indices (H') and number of species (S) in managed grasslands

	Old		Actual			
	5	6	7	8	9	10
H'	5.06	4.13	3.66	3.46	3.60	3.50
Var H'	0.014	0.015	0.011	0.033	0.009	0.018
S	36	26	26	22	27	18
Number of ind. examined	208	202	202	115	275	104

All differences between old and actual grasslands significant (t - test 2.48-3.57, $p < 0.02$ - $p < 0.001$)

4. DISCUSSION

What factors determine the diversity of spider communities? Is it possible to identify factors responsible for reduction of species diversity? We have analysed the effect of three factors that seem to be important: (1) the intensity of stress affecting spider communities, (2) the size of grasslands managed in the same way, and (3) the diversity of the herb layer as measured by the number of plant species.

Stress is defined here as a set of factors that can eliminate some species. Floods accounting for a large amplitude of water level on grasslands were considered as the heaviest stress. A weaker stress resulted from a high, but showing little seasonal variation, ground water level. Also haymaking was a source of stress changing environmental conditions, and limiting living space for spiders. It was assumed that the rate of species elimination was proportional to the frequency of mowing.

It can also be assumed that the size of the grassland is important as it can determine the possibility of immigration or emigration when the conditions deteriorate. It can thus determine the possibility of survival in a given area despite occasional unfavourable periods.

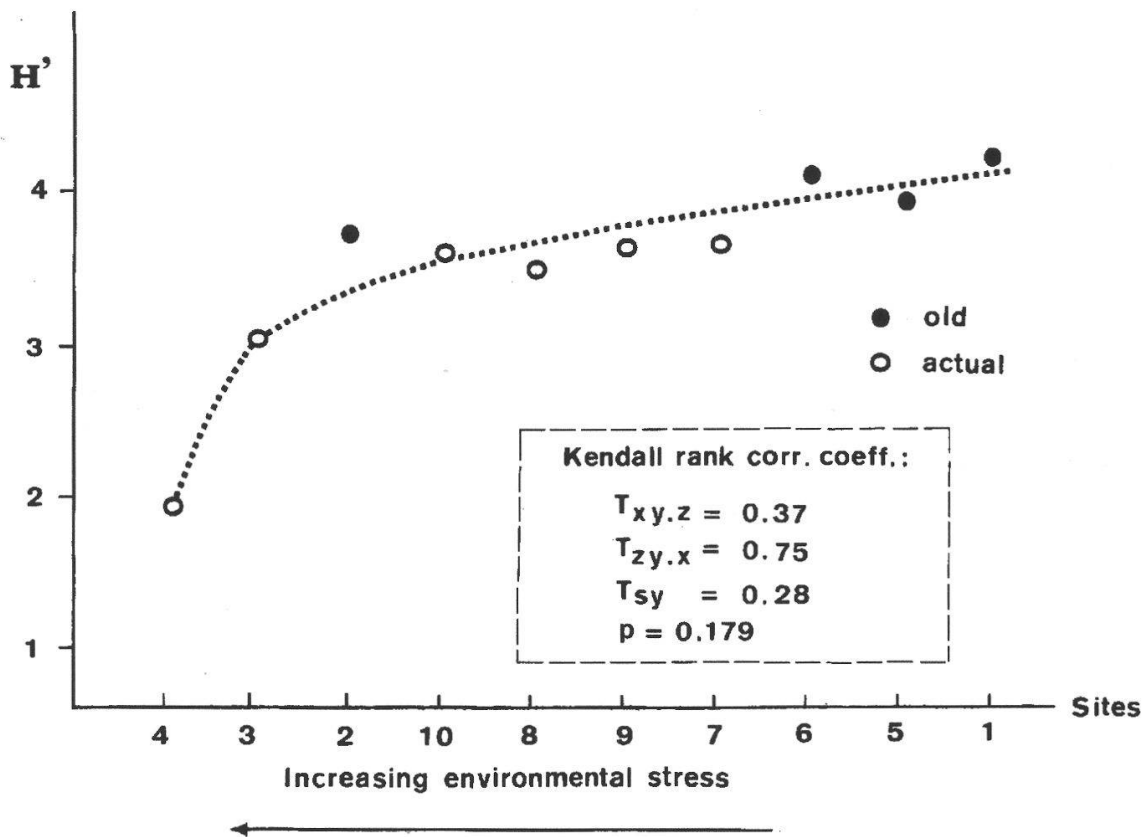


Fig. 1. Correlation between environmental stress (x), patch size (z), number of plant species in sward (s) and spider species diversity (y)

Using Kendall partial rank correlation, a negative relationship was found between the intensity of environmental stress, patch size and spider diversity ($=-0.37$). It was shown, that patch size is an important factor influencing species diversity. When the effect of stress has been partialled out, the correlation between the size of the area and spider diversity is -0.75 (figure 1). The number of plant species in the sward is of smaller importance. The correlation between the plant diversity and spider diversity for all the sites combined is 0.28 , $p=0.179$. A higher correlation has been found for the group of natural grasslands ($=0.67$, $p=0.167$).

What is the living strategy of the species that survived and predominate on the actual, managed grasslands?

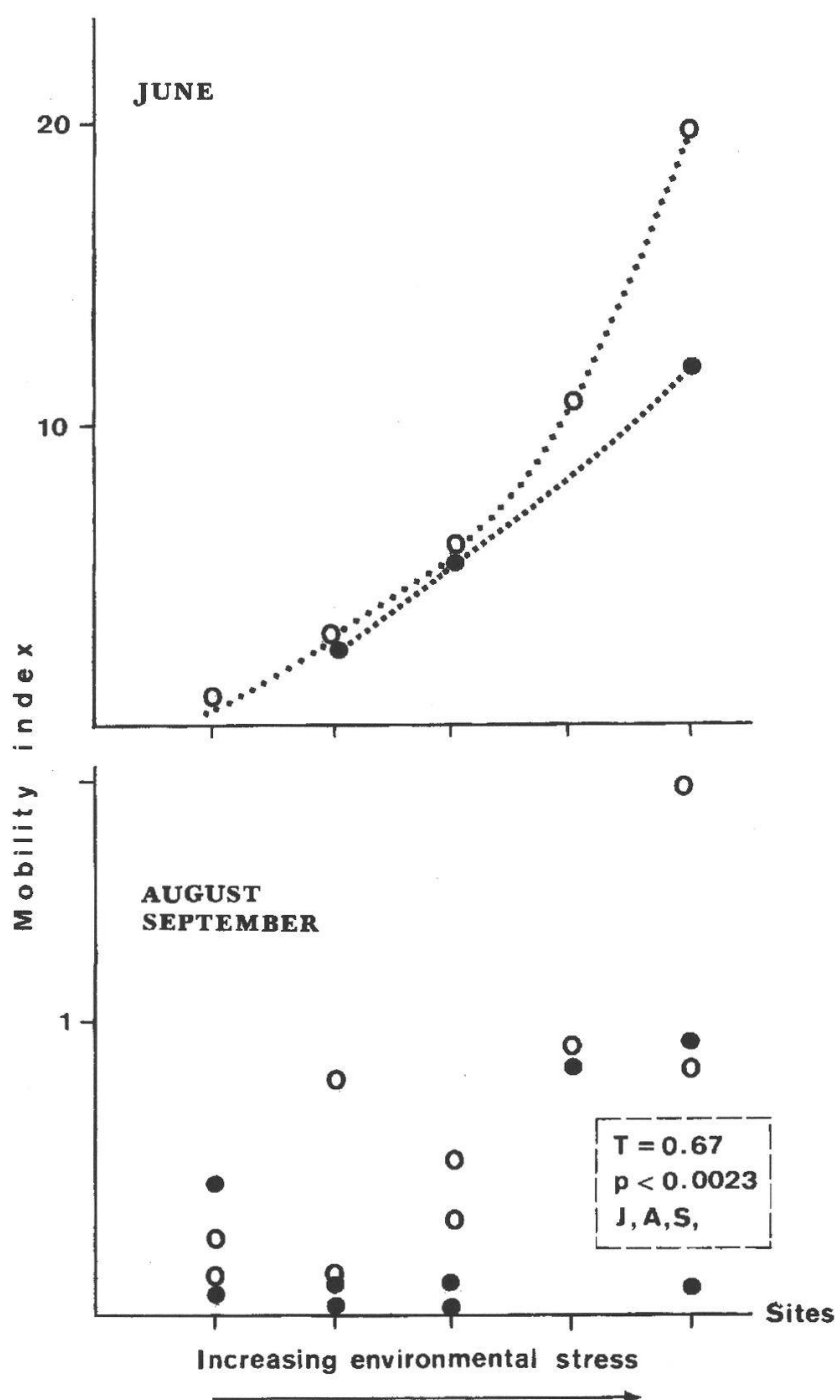


Fig. 2. Correlation between environmental stress and mobility index of spiders.

In all sites the community is predominated by 4 species: *Pardosa palustris*, *Erigone atra*, *Dicymbium nigrum* and *Pachygnatha degeeri*. They account for more than 55% of the total number of individuals caught by quadrat method. All of them are eurytopic species (RUZICKA 1987), common in crop fields, and characterized by well developed tendency to migrations. It has been found that *P. palustris* is characterized by the highest aerial dispersal rate within the genus *Pardosa* (RICHTER 1970).

Moreover, individuals of this species migrate from grasslands to crop fields on the ground surface (CIESIELSKA et al. in press). It is also that Linyphiidae are strongly aeronautic (GLÜCK et al. 1990, SUNDERLAND et al. 1986, THORNHILL 1983). The mobility index (the ratio of mean number of individuals per one pitfall trap to the density) was compared in all actual, managed grasslands.

It was found, that the mobility increases with the increase of environmental stress, so with the deterioration of living conditions for spiders (figure 2).

It seems, therefore, that the ability to migrate by air or on the ground surface is the important factor determining the possibility of survival and dominance of spider species at the present intensity of grassland management.

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Experiences with Spider Exhibitions in The Netherlands

par
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Summary: During the past three years, four spider exhibitions for the general public were organized in The Netherlands. Most successful was the exhibition in the Museon, Den Haag (The Hague). It consisted of eleven panels giving basic information. In show-cases, several preserved specimens were displayed, together with photographs of the same spiders alive and their ways of catching prey. In vivaria some Dutch spiders, a bird-eating spider, a black widow, and a Nephila-spider were shown. Variation among spiders was demonstrated by slides, the building of orb-webs by computer graphics. Visitors could test their knowledge of spiders with the aid of a booklet and flip panels. The press was very much interested in this exhibition, leading to announcements in most of the Dutch newspapers and in radio and television programs. This resulted in about 30,000 visitors within two months. Most visitors appreciated the exhibition, but some were disappointed, for instance because of the limited amount of living tarantula's, or because their arachnophobia was not cured despite of promises in the press.

1. INTRODUCTION

Many people are afraid of spiders. But if these anxious people are asked to draw a spider, the results are usually disappointing (figure 1). The number of body tagmata, legs, eyes and mouthparts are most times not in conformity with reality. It can be concluded that people with fear of spiders, many times do not know what they are afraid of. Probably, we have to do with a very serious case of unknown, unloved. The case is so serious, because the unreasoned fear for spiders may have some major drawbacks on subjects concerning arachnology and arachnologists:

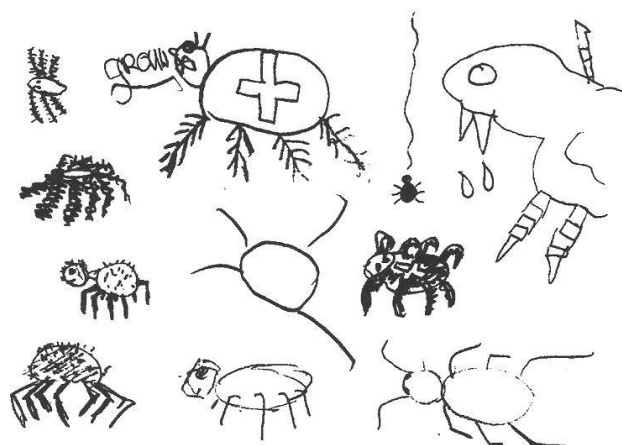


Fig. 1 - Some drawings of spiders, made by people afraid of spiders.

1. Spiders are very interesting animals, but few will ever know if people are afraid of them *beforehand*.
2. If spiders are not accepted as animals worth to be studied, how will arachnology ever be accepted, and arachnologists be employed as such?
3. Why should nature be protected, if it is full of terrifying animals like spiders?

So, there are several reasons to accept an invitation to make a spider exhibition. This was done four times (see figure 2 and table I): in Vianen, Haren, Den Haag (The Hague), and in Dokkum. Most successful was the exhibition in Den Haag in the Museon. This was formerly the Museum for Education (in Dutch: Museum voor het Onderwijs), that has developed now into a rather large popular science museum, with exhibits concentrating on five main areas: geology, natural history, history, science, and ethnology. Education is still very important in the Museon, and there are some classrooms for giving lessons and practice programs with schoolchildren and other visitors. In summer, some classrooms are used for additional exhibitions, for instance a spider exhibition in 1990. Information in this paper refers to the exhibition in the Museon, unless stated otherwise.

2. MATERIAL AND METHODS

Basic information was given by some panels with photographs and short texts. First, these panels were made as cardboard mock-up's, exhibited in a public library in Vianen, where reactions of visitors were observed. The final panels were made of chipboard, giving information about systematic position of spiders, outer and inner morphology, sense organs, sexual organs, courtship, parental care, mimicry, ballooning and the "usefulness" of spiders. Special care was taken to make it easy for the general public to remember the information well, by linking it up to familiar subjects. For instance, on the panel with information about sense organs (figure 3), comparison is made with sense organs of man.



Fig. 2 - Map of The Netherlands, showing locations of spider exhibitions.

Prey capture was displayed in show-cases by preserved spiders (showing the size of the spiders), together with photographs of the same spiders alive (showing colours), and photographs of their ways of catching prey. The building of orbwebs was demonstrated by computer graphics. In vivaria some Dutch spiders, caught by the author, were shown, like water spiders (*Argyroneta aquatica* (Clerck)), wolf spiders (*Pardosa amen-tata* (Clerck)), *Pirata* sp.), daddy-long-legs spiders (*Pholcus phalan-gioides* (Fuesslin)), jumping spiders (*Salticus*

scenicus (Clerck)), house spiders (*Tegenaria atrica* C.L.Koch), and orbweb spiders (*Larinioides cornutus* (Clerck)). Prof.dr. T.E. Christenson (Tulane University, New Orleans) kindly provided some giant orbweb spiders (*Nephila clavipes* (Linnaeus)). Some tarantula's (*Euathlus smithi* (Cambridge), *Melopoeus minax* (Thorell)) and a black widow spider (*Latrodectus* sp.) were borrowed from a zoo.

Variation among spiders was demonstrated by slides, alternately showing a short word (green, spiny, round, etc.) and a spider with that property. Visitors could have a close look at a preserved spider by looking through a stereo-microscope. Meanwhile the spiders could be manipulated without causing damage with the aid of brushes. Some other microscopes showed urticating hairs of a bird-eating spider and preparations of sexual organs.

Finally visitors could test their knowledge with the aid of a booklet and flip panels (see MILES et al. 1988, fig. 9.12) showing various arthropods of which the spiders had to be recognized. Visitors could ask questions to a museum teacher, that was always present. Visitors were counted at the entrance of the Museon (Den Haag), the botanical gardens (Haren), and the nature museum (Dokkum), respectively. Thus, no distinction was made between people actually visiting the spider exhibition and people remaining in other parts of the institutions. Visitors of the test exhibition in the public library in

Vianen have not been counted. Reactions of visitors could only quantitatively be derived from the remarks written down (mainly by children) in the visitor's book. No inquiry was held.

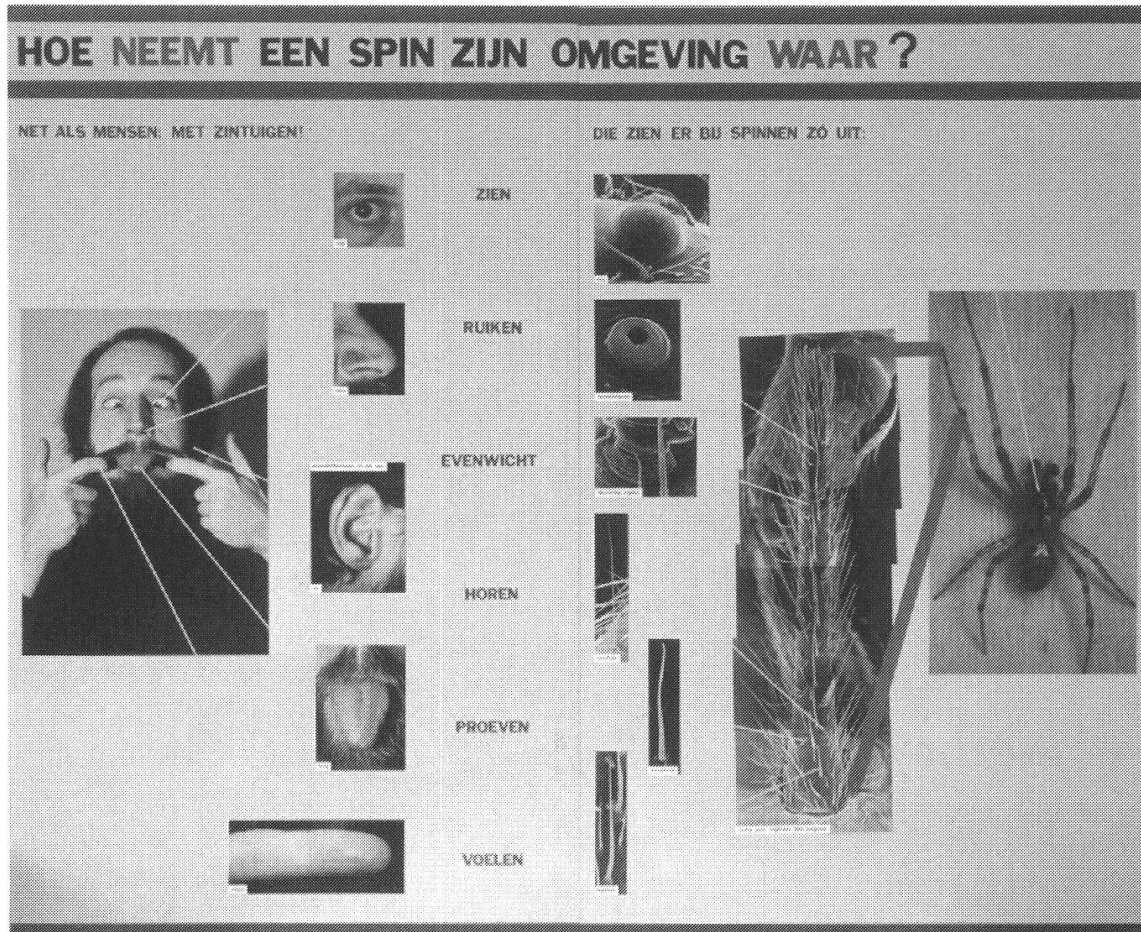


Fig. 3 - Example of an information panel, showing sense organs of spiders compared with sense organs of man.

3. RESULTS AND DISCUSSION

3.1 The press

Quite unexpectedly, the press was very much interested. For several days, two staff-members of the Museon and the author were occupied answering questions of journalists. This resulted in announcements and articles in, as far as traced, six national newspapers, forty-one local newspapers, one Belgian newspaper, and one popular science magazine for children. Moreover, staff members and the author were interviewed more extensively by two newspapers, a women's magazine, three local and two national radio stations. The author was invited to appear in two television programs: a talk show and the breakfast news.

Concerning the interests of the press, it was disappointing that most questions were about humans instead of spiders. It is recommendable to have a quick answer on questions like "Why are people afraid of spiders?" and "How many people die from spider bites?", so that more time is left for the spiders. Mistakes made by the press are sometimes amazing. Staff members of the Museon handed out photographs to the press, that showed a rather harmless bird-eating spider, as was written on the back of the photograph. At least 17 newspapers printed this photograph telling that it was a very dangerous black widow. This problem can be avoided by writing the text on the front of the photographs, or by providing photographs of black widows only.

3.2 The public

Thanks to all the publicity, many people in The Netherlands decided to have a look at the exhibition. A total number of 34903 people visited the Museon during the spider exhibition (July and August 1990). Custodians declared that most of them came especially to see the spider exhibition. However, this was difficult to check, because an inquiry was not held. Only the number of visitors could be compared to the number of visitors in the same period in 1989 (see table I). At that time, there was a butterfly exhibition in the Museon. It can be concluded that spiders attracted 32% more visitors than butterflies, but this result may be biased by other temporary exhibitions, not concerning natural history subjects. Nevertheless, even more spectacular increases (89% and 659%, see table I) were recorded during two other exhibitions. Thus, it seems clear that spider exhibits are able to attract a lot of people.

But how pleased were all these people with the exhibition? Of the 868 remarks written down in the visitor's book, 439 (51%) were only positive, 279 (32%) contained positive as well as negative elements, and 120 (14%) were only negative. 30 reactions (3%) were not clear, because they did not refer to the exhibition or because they were written in a foreign language not understood by the author. The most numerous reactions are summarized in table II. It is good to see that many people found the exhibition interesting, informative, or beautiful in some way, and that microscopes, living spiders and a living teacher were appreciated. Unfortunately, only 33 persons wrote down that their fear for spiders had decreased. Probably, most of the negative reactions were evoked by the enormous publicity. This was also the feeling of the museum teachers. People expected a very big exhibition and were disappointed to see that it was only one classroom, with only a small amount of living tarantula's that were hiding, and might not be touched. Also, quite a lot of people complained that their arachnophobia was not cured despite of promises of the press.

Tab. I - Data concerning spider exhibitions organized by the author in The Netherlands. The numbers of visitors during the exhibitions are compared to the number of visitors during the same period in the year before without spider exhibition.

location	institution	period	year	number of visitors	increase
Vianen	public library	6-29 September	1989	not counted	not known
Haren	botanical gardens	13 May -11 June do. (no spider exh.)	1990 1989	8376 4430	89%
Den Haag	Museon do. (no spider exh.)	July & August	1990 1989	34903 26499	32%
Dokkum	nature museum	12 March - 31 May do. (no spider exh.)	1991 1990	2650 349	659%

Tab. II - Most numerous reactions written down in the visitor's book during the spider exhibition in the Museon.

Positive reactions	number of reactions	% of total nr.
interesting\fascinating	152	17.5%
informative	123	14.2%
beautiful (photographs/exhibit/spiders)	78	9.0%
appreciation for microscopes	37	4.3%
fear for spiders decreased	33	3.8%
appreciation for living spiders	19	2.2%
appreciation for presence teacher	15	1.7%
Negative reactions of total nr.	number	% of total nr. of reactions

positive, but ...	203	23.4%
scaring	198	22.8%
exhibition is too small	92	10.6%
still afraid of spiders	45	5.2%
not enough living (bird eating) spiders	39	4.5%
not possible to touch spiders	16	1.8%
fear for spiders increased	14	1.6%

4. CONCLUSIONS

Although (or perhaps: because) many people are more or less afraid of spiders, these animals have the image of being "sensational". Even a rather small exhibition may cause, when the press gets interested, a chain reaction of publicity. This may result in more visitors than estimated, with high expectations. To meet (some of) these expectations, the exhibition has to be bigger than one classroom and should show a rather large amount of bird eating spiders. The question is, whether such a more spectacular exhibit will not undermine the goal each educational spider exhibition should have: to teach the public what spiders are, and what they are doing.

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On the biogeography and faunistics of European spiders: latitude, altitude and insularity

par
Seppo Koponen

Summary: The number of spider species known from small central European countries or areas (30–40 thousand sq.km) varies from 600 to 875, the highest being in Switzerland. In the more northern, small and flat areas, Denmark and Estonia (ca. 45 t.sq.km), 510–520 species are found. In larger central European countries (70–550 t.sq.km) 600–1400 species are known, of these the lowest numbers are from the somewhat isolated Great Britain and the highest from France. In northern Europe, large Fennoscandian countries (320–410 t.sq.km) have 535–695 species. About 2200 species are known from the huge USSR (22 402 t.sq.km); of these 940 from the Russian plain. In well-studied small areas, a markedly high number of species can be found, e.g. 511 (55 % of the total German fauna) in West Berlin and 425 (67 % of the Finnish fauna) at Tvärminne. The areal size is less important than the latitude, altitude and isolation. An increase in each of the latter has the effect of decreasing the richness and diversity of spider fauna; the family Linyphiidae (s.lat.) being dominant in extreme high, northern or insular conditions in Europe. The number of species in Slovenia (46°N) and Inari Lapland (69°N), areas of equal size (20 t.sq.km), are 530 and 220 respectively. Of ecological islands on mainland, high mountains and raised bogs offer a site for northern relicts, warm slopes and cliffs and, to some extent, caves for southern species. Environmental problems, especially in densely populated areas of Europe, have brought out the need for accurate faunistic data on rare, endangered species (and on their endangered habitats which are often ecological islands on mainland). A common European mapping program of spiders, e.g. using UTM squares of 50 x 50 km, would be very welcome for both biogeographical and conservation studies. Naturally, it is not possible to begin this mapping without intensive cooperation between specialists of all countries and without a center for the practical compilation work.

1. INTRODUCTION

Nature in Europe, including its spider fauna, has been greatly affected by the Ice Age. The ice sheet covered northern Europe during the last glaciation and its retreat, about 15 000 – 8000 years ago, started, in northern Europe a successional development of different ecosystems from tundra deserts to the recently occurring ones. The effect of the Ice Age on the spider fauna of northern and central Europe is well-known and easy to understand. However, the glaciation also affected the southern, Mediterranean spider fauna (e.g. BRIGNOLI 1981).

When considering the European spider fauna and its development after the glaciation, some debated concepts must be mentioned. The connections with eastern (Siberian-Alaskan) and western (North American) areas have been much discussed. Because of large ice-free areas in Siberia connected with the Beringian land bridge to ice-free parts of Alaska, marked faunal migration from Beringia could be expected (e.g. GORODKOV 1984), especially in tundra and taiga forest zones of Europe. The possibility of North Atlantic land bridges has been also discussed (LINDROTH 1957), but they seem to be very improbable and the faunal resemblance must be explained otherwise. Ice Age refugia are also interesting and much treated phenomenons (e.g. LINDROTH 1969, ASHMOLE 1979). The recent range of certain plants and animals could often be explained nicely by small-sized refugia (nunataks or coastal refugia), surrounded by ice sheet. The importance of small-sized refugia seems to be more favoured in North America than in Europe today (see e.g. PIELOU 1991). The occurrence of large-sized refugium areas is commonly accepted (e.g. BRIGNOLI 1981; MAURER & THALER 1988).

The natural expansion routes for the fauna of postglacial Europe were from the east, southeast and south. Within Europe, different faunal elements spread northwards and so the recent spider faunas seem to be of mixed origin. One could expect that the spider fauna of Finland, at the western end of the taiga forest zone, would be rather similar to that in Yakutia, eastern Siberia. However, only about 40 % (150 species) of the Yakut species (about 400 species known, MARUSIK et al. unpubl.) are found in Finland; for comparison, about 75 % (450 species) of the Finnish and British spiders are in common (ROBERTS 1987, LEHTINEN et al. unpubl.).

The ice sheet disappeared in northernmost Europe less than 10 000 years ago. Thus, we could think that the spider fauna of northern areas is still developing and that not all potential species have arrived. Spiders are effective in dispersal, especially species using ballooning. For example, within seven study years five species reached the new volcanic island of Surtsey near Iceland; area of about 2.5 sq. km. All were linyphiids (s. lat.); four occurring in Iceland but one probably arrived from the British Isles (LINDROTH et al. 1973). CRAWFORD (1985) found 43 species of spiders in a totally destroyed and vegetation-free site at Mount St. Helens, Washington, one and two years after the devastating eruption. They all belonged to groups known to be ballooners. MEIJER (1977) studied immigration into a new polder in the Netherlands during

a period of four years. More than 80 species were found and about 20 of them were regarded to have established populations in the area (MEIJER 1977). Ballooning groups have probably reached in the north the areas where they can live, but for non-ballooners it is not always clear. Naturally the spider faunas are dynamic and changing, basically due to climatic changes. There are several recent immigrants from the European continent over the Channel to the British Isles; partly probably caused by man (e.g. HAMBLER & LINFELD 1991).

2. AREA, LATITUDE AND ALTITUDE

The number of spider species known is naturally higher in southern areas than in the north (table I). In Central Europe, 600–850 species can be found in an area of 30 000 – 40 000 sq. km. The effect of latitude and altitude can be seen in the species numbers of Switzerland (875) and Denmark (510), both about 40 000 sq. km. Latitudinal effect may explain the difference in numbers between nearly equal-sized Holland (605) and Denmark (510), both countries being flat. The great number of islands belonging to Denmark may also be a reducing factor in species number. Sweden, Norway and Finland are rather large countries, but due to their northern situation, the species numbers are rather low (535–695). The species number in Holland and Finland is equal (605); the area of Finland being tenfold that of Holland. On the other hand, isolation from the European continent causes the lower species number in Great Britain (620, i.e., less than in Belgium on the other side of the Channel). In addition, the spider fauna of Great Britain has been studied thoroughly by both amateurs and professionals and is thus very well-known. The species number in large countries (Germany 925, Sweden 695, France 1400, Russian plain 940, USSR 2200 species) is not naturally directly correlated with the area. It is not possible to investigate wide areas in as detailed a way as the smaller ones.

The size of a study area (country, province etc) is not very important when dealing with the number of species to be found. Thus PALMGREN (1972) reported 425 species (70 % of the Finnish fauna) from the surroundings of the Tvärminne Zoological Station, southern Finland, and PLATEN et al (in press) as many as 511 from West Berlin (480 sq. km; 55 % of German species) (table II). It must also be borne in mind that both Tvärminne and Berlin are lowland areas without mountains.

Tab. I. - Approximate number of spider species known from different European countries/areas; 1: number of species; 2: area (1000 square km), * : ice-free area; 3: species/1000 sq. km; 4: maximal altitude (m); 5: reference.

	1	2	3	4	5
Slovenia	530	20.2	26.2	2863	NIKOLIC & POLENEC, 1981
Belgium	645	30.5	21.1	690	BOSMANS & MAELFAIT, 1986
Netherlands	605	33.9	17.8	320	VAN HELSDINGEN, 1988
Switzerland	875	41.2	21.2	4630	MAURER & HÄNGGI, 1990
Pyrenees	860	~40	21.5	3404	BOSMANS & DE KEER, 1986-87
Baden-Württemberg	670	35.7	18.8	1493	RENNER, unpubl.
Denmark	510	43.1	11.8	170	BØGGILD, pers. comm.
Estonia	516	45.1	11.4	317	VILBASTE, 1987
Bavaria	750	70.5	10.6	2960	BLICK, unpubl.
"DDR"	705	108.3	6.5	1220	MARTIN unpubl.
Czechoslovakia	860	127.9	6.7	2650	BUCHAR, pers.comm.
England & Wales	600	151.2	4.0	1085	ROBERTS, 1987
Great Britain	620	230.7	2.7	1340	ROBERTS, 1987
Alps	1000	~240	4.2	4810	THALER, 1980
Romania	850	237.5	3.6	2540	WEISS, 1988
"BRD"	855	249.5	3.4	2960	BAEHR & PLATEN, pers.comm.
Poland	740	312.6	2.4	2500	WOZNY, 1985
Germany	925	357.8	2.6	2960	PLATEN, pers.comm.
France	1400	551.0	2.5	4810	JONES et al., 1990
Norway	535	323.9	1.6	2470	HAUGE 1989
Finland	605	338.1	1.8	1324	LEHTINEN et al. unpubl.
Sweden	695	411.5	1.7	2123	KRONESTEDT pers.comm.
Russian plain	940	~2000	0.5	(low)	MIKHAILOV pers.comm.
USSR	2200	22402	0.1	7495	MIKHAILOV pers.comm.
Shetland	90	1.4	64.3		ASHMOLE 1979
Faroes	67	1.4	47.9		BENGTSON & HAUGE 1979
Svalbard	14	8.0*	1.8		TAMBS-LYCHE 1967
Iceland	90	89.7*	1.0		ENCKELL 1985
Greenland	69	341.7*	0.2		KOPONEN 1982

Tab. II - Composition of the spider fauna of certain well-studied sites at different latitudes. 1: number of species, 2: percentage of linyphiids s.lat., 3: number of families, 4: reference.

	1	2	3	4
Isfjord, Svalbard (78°N)	13	93%	2	HOLM 1958
Kevo, Finland (70°N)	164	77%	18	KOPONEN 1984
Tvärminne, Finland (60°N)	425	42%	24	PALMGREN 1972
Berlin W, Germany (52°N)	511	36%	33	PLATEN et al. in press

Tab. III - Number of families (according to PLATNICK 1989) in certain countries/area

World	105	(PLATNICK 1989)
USSR	46	(MIKHAILOV, pers.comm.)
Switzerland	39	(MAURER & HÄNGGI 1990)
Russian plain	36	(MIKHAILOV, pers.comm.)
Belgium	35	(BOSMANS & MAELFAIT 1986)
Great Britain	35	(ROBERTS 1987)
Norway	29	(HAUGE 1990)
Finland	27	(LEHTINEN et al. unpubl.)
Shetland	12	(ASHMOLE 1979)
Iceland	10	(ASHMOLE 1979, EINARSSON 1984)
Greenland	10	(HOLM 1967, KOPONEN 1982)
Svalbard	2	(HOLM 1958, TAMBS-LYCHE 1967)

The spider fauna in the northern areas is less rich and less diverse than that in the south (table III).

The family Linyphiidae (s. lat.) is dominating in species numbers when moving northwards (table II). The opposite is true for many other families, such as Salticidae, where the species number from southern Europe (40–45°N) to the North (66°30'N) decreases from 88 to 11 (PROSZYNSKI 1978). Some families have the northern limit of their range near the southern coast of the Baltic Sea (e.g. Zodariidae) and several have barely colonized the southernmost part of Sweden and/or Norway but are absent from most of these countries, as well as totally absent from Finland, for example, Atypidae, Uloboridae, Oonopidae, Dysderidae and Theridiosomatidae.

The effect of latitude is shown when comparing the species numbers of two equal-sized (20 000 sq.km) areas: Slovenia (46°N) and Inari Lapland (69°N). The number of known species in Slovenia is 530 and in Inari Lapland 220 (NIKOLIC & POLENEC 1981, KOPONEN 1984 and unpubl.).

The effect of altitude can be seen best on mountains which are islands surrounded by lowlands. Great mountain areas of Europe, such as the Alps, the Carpathians and the Pyrenees have their special fauna with a high number of endemic species. For example, BOSMANS & DE KEER (1986–87) regarded 12 % of the found 860 Pyrenean species as endemics. The biogeography, including endemism, of the spider fauna of the Alps has been studied intensively by THALER (e.g. 1980) and MAURER & THALER (1988). The endemic species can be found in different altitudinal zones in the mountains; in the Pyrenees they were common in subalpine and especially montane forest zone sites (BOSMANS & DE KEER 1986–87).

At high altitudes the number of species as well as of families decreases (as towards the north). Thus, in Switzerland, the number of species and families occurring in all altitudinal zones is 21 and 9 respectively, and that of species restricted to alpine–nival zones is 13 and 4 (MAURER & HÄNGGI 1990); altogether 11 families in alpine and nival zones. In the East Alps, THALER (1988) found 49 species belonging to 7 families from the nival zone. In the Pyrenees, 52 species and 12 families of alpine and arctic–alpine species were found (BOSMANS & DE KEER 1986–87). In northernmost Sweden, the Torneträsk area, nine species of two families (eight linyphiids s. lat. and one lycosid) were found in the high alpine zone, above 1300 m; and 14 species of three families occurred only in the alpine zone, above 600 m, although as many as 80 species were altogether observed in the alpine zone (HOLM 1950). The families dominating at a high altitude in Europe are linyphiids (s. lat.), lycosids and gnaphosids.

3. INSULARITY

3.1. Ecological islands

The occurrence of northern (relict) species in the Central and South European mountains is well-known. MAURER & HÄNGGI (1990) listed 30 arctic–alpine and boreal–subalpine species from Switzerland, and BOSMANS & DE KEER (1986–87) 14 arctic–alpine from the Pyrenees. Arctic–alpine species have been reported, in smaller numbers, e.g. from the High Tatras in Czechoslovakia (SVATON 1983) and the Pirin Mountains in Bulgaria (DELTSHEV 1990).

However, the spider communities at high altitudes in the Alps and, e.g. in northern Fennoscandia, differ. Thus PALMGREN (1973) reported that only three of the most abundant 15 sublapidicolous alpine spiders at Kilpisjärvi, Finnish Lapland, were among the abundant sublapidicolous species in the nival zone of the East Alps. At least for some arctic–alpine species the habitat requirements become more eurytopic in the north. For example, *Tiso aestivus* occurs in Switzerland in the alpine and nival zone (above 2300 m; MAURER & HÄNGGI 1990), has been found in the subalpine and alpine zone at Torneträsk, Swedish Lapland by HOLM (1950); and is typical in the alpine zone at Kevo, northernmost Finland (where the alpine zone begins at 300 m), but can be found there also at man-made open sites in the forest zone (KOPONEN 1988).

Mountains offer an island for northern spiders in the south, as do raised bogs: the occurrence of northern plant and animal species on bogs has been known for a long time. PETERSEN (1954) presented the concept 'mire species' for them. Typically, these mire species occur in the southernmost part of the range only on bogs and in the north they are more eurytopic. This has been found in spiders as well, e.g. *Pardosa hyperborea*, *Gnaphosa lapponum*, *G. microps* and *Robertus lyriifer* are found in southern Finland only on peat bogs and in Finnish Lapland these species are markedly eurytopic. The same phenomenon is true for the bogs of Central Europe. Bogs are very threatened biotops, many of them have been dried; so that even in Finland, where 30 % of the land was regarded as bogs in the 1950's it is now difficult to find large natural bogs in the southern part of country. The effect of drying is well-known: the specialized bog species disappear and more eurytopic species become abundant (KOPONEN 1979).

Islands for both thermophilous and hygrophilous species are also rocky slopes (stony debris) where some rare relict species have been found, e.g. the Siberian linyphiid *Wubanoides longicornis* in Czechoslovakia (RUZICKA 1990). Warm slopes and cliffs offer an island for many southern thermophilous species, especially in Central Europe (e.g. STEINBERGER 1988) but also in the north. On the other hand, shaded moist cliffs are sites for northern species.

Nowadays natural forest habitats have become widely scattered in populated areas. And even in northern Europe, e.g. in Finnish and Swedish Lapland natural primeval forests has been reduced greatly during recent years. Although there seem to be only a few if any species restricted to boreal primeval forests (VÄISÄNEN & BISTRÖM 1990) they are optimal biotops for many spiders, especially linyphiids.

Caves are a special environment, patchily distributed or insular, with often very specialized spider fauna. Obligate cave-inhabitants, troglobites, are strongly adapted to living in caves. Troglobites occur in caves of southern Europe, mainly around the Mediterranean Sea. Typical groups are blind dysderids and linyphiids (*Troglohyphantes* and *Centromerus*) and some leptonetids (DEELEMEN-REINHOLD 1981). An extraordinarily high number of blind spiders is known from SW Yugoslavian caves compared to the surrounding areas, such as East Serbia, Greece, Bulgaria and Italy. For example, more than ten blind or semiblind species of the *Troglohyphantes salax* group have been reported from Yugoslavia and only one from nearby Bulgaria (DEELEMEN-REINHOLD 1981). Specialized troglobites occur commonly also in the Pyrenees and on some Mediterranean islands. In northern Europe, troglophilic species are typical. They have successfully colonized widely scattered caves, so that e.g. *Meta menardi*, *Metellina merianae*, *Nesticus cellulanus*, *Porrhomma convexum* and *Lepthyphantes pallidus* can be found at the Arctic Circle in Norway (HIPPA & KOPONEN 1988). In general, the total number of spiders found in caves in northern areas is not markedly smaller than that in southern Europe, except perhaps in some particular karstic areas; e.g., 61 species from seven caves in Scandinavia vs. 76 from 410 Bulgarian caves (HIPPA et al. 1984, DELTSHEV 1983). BRIGNOLI (1972) listed 177 species from Italian caves.

3.2. North Atlantic islands

The number of species (and families) decreases strongly when moving from the main islands of Britain or from Scandinavia to the North Atlantic islands (table I). The faunas of both Shetland and the Faroes are equally similar with those of West Scandinavia (Norway) and the Scottish mainland, but the fauna of Iceland resembles more Scandinavian than Scottish faunas (ASHMOLE 1979, ENCKELL 1985). In general, the Nearctic element (probably via Greenland) is small; some Icelandic species can be mentioned. Of these, the lycosids *Pardosa furcifera* and *P. groenlandica* were found in large numbers in the nineteenth century, but seem to be extinct now (BRAENDEGAARD 1958, ASHMOLE 1979). The fauna of Greenland consists of Holarctic (40 %), Nearctic (40 %) and Palaearctic (20 %) species (HOLM 1967, KOPONEN 1982). In Svalbard, the majority of the species are circumpolar (HOLM 1958).

When comparing two arctic study sites, Isfjord in Svalbard (HOLM 1958) and Hazen Camp in the Ellesmere Island (LEECH 1966) the main difference is the family number (table IV). Only two indigenous families (12 Linyphiidae and one *Micaria* species) were found in Svalbard but four families (9 Linyphiidae, 2 Lycosidae, one Dictynidae and Thomisidae species) in the even more northern Ellesmere Island; the total number of species being 13 at both sites. The main factor seems to be the isolation: the distance from Svalbard to Greenland is 450 km, to Scandinavia 700 km and to Novaya Zemlya 900 km. In the Canadian high arctic archipelago the sounds are much narrower (ca. 100 km).

Tab. IV - Comparison of the faunas of two arctic sites, Isfjord in Svalbard and Hazen Camp in Ellesmere Island.

	Isfjord	Hazen Camp
Number of species	13 (+2 introd.)	13
Number of families	2 (+1 introd.)	4
Latitude	78 °18'–30'N	81°49'N
Total area of island	65 300 sq.km	198 100 sq.km
Ice-free area	8 000 sq.km	117 600 sq.km
Isolation, distance	450–900 km	~100km

4. HUMAN INFLUENCE: ENDANGERED SPECIES

In some countries spiders have been included in "Red Books" as endangered species, and in many countries especially in Central Europe, this listing is being done. For example, in Finland (ANON. 1985), 27 species of spiders (ca. 4 % of fauna) were included, and two of these were listed as extinct species (e.g. *Agelena labyrinthica*). In Sweden, three species (*Atypus affinis*, *Araneus nordmanni* and *Hyptiotes paradoxus*) were included in the list of endangered species of Swedish woodlands (EHNSTRÖM & WALDEN 1986). MARTIN, PLATEN & SACHER (in prep.) regard 12 species as extinct and 25 more as highly endangered in Germany.

When dealing with the whole European spider fauna, the term endangered species varies very much in different areas (countries). Thus species listed in the Red Books in northern Europe may be commonly found in more southern regions. Although local lists of endangered species may be based on different levels of knowledge and on different opinions concerning the threat, they offer valuable information about rare species and often about their special habitats which should naturally be protected and not the species as such. Although DUFFEY (1974) reported that only one or two native British spiders had been lost by the land-use changes and no more seemed to be in actual danger, the present situation in densely populated areas of Europe seems to be markedly worse. The species of small-sized ecological islands (e.g. bogs) are endangered in particular.

A common European mapping system for spiders, such as the European floristic survey publishing 'Atlas Florae Europaeae', could give the basic data for conservation work. This kind of mapping (e.g. using 50 x 50 km UTM-squares) would be very welcome, but it will also be very demanding and time-consuming work. Local mapping programs are already at work in many countries, e.g. the Spider Recording Scheme in Great Britain (e.g. SMITH 1990).

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Zur Biochemie des Giftes von *Cupiennius salei* (Ctenidae)

par

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Summary: By a HPLC purification sequence, one toxin from the venom of the ctenid spider *Cupiennius salei* could be isolated. The *Cupiennius salei* toxin (CSTX) has a molecular weight about 12 kD and causes a high mortality in a *Protophormia* biotest.

1. EINFÜHRUNG

Biochemische Untersuchungen an Spinnengift haben sich ursprünglich wegen der leichten Gewinnbarkeit des Giftes auf Theraphosiden und aus medizinischen Gründen auf humantoxische Arten beschränkt. In den letzten 10 Jahren stehen v.a. Araneiden und Tetragnathiden im Vordergrund des Interesses, da ihre toxischen Polyamine für neurophysiologische Untersuchungen von besonderem Interesse sind. Über das Gift der Spinnenart, die heute vermutlich am besten untersucht ist, die Ctenide *Cupiennius salei*, ist jedoch nichts bekannt. Wir haben uns daher dieser Art zugewandt und berichten hier über erste Ergebnisse.

2. MATERIAL UND METHODE

Giftgewinnung. *Cupiennius salei* wird bei uns in einer Dauerzucht gehalten (MALLI & NENTWIG, dieser Band). Adulten, weiblichen Tieren wurde in zweiwöchigen Intervallen Gift entnommen. Hierzu wurde es nach elektrischer Reizung in Mikrokapillaren aufgefangen, gepoolt und bei -80°C gelagert.

Biotest. Um einzelne Giftfraktionen auf ihre Toxizität zu überprüfen, wurden jeweils

Aliquots in 60 mM Natriumacetat (pH 5) oder in Insektenringer in das Coxalgelenk II der Fliege *Protophormia* sp. (Calliphoridae) eingespritzt (0.3 µl). Als Kontrolle dienten Injektionen nur mit Insektenringer bzw. Puffer.

Elektrophorese. SDS-Polyacrylamid-Gelelektrophorese wurde mit dem Phastsystem (Pharmacia) durchgeführt. Die Geldimension betrug 43 x 50 mm. Das Puffersystem wurde nach LAEMMLI (1970) wie folgt modifiziert: Sammelgel: 7.5% Acryl-/Bisacrylamid (29.1:0.9); 125 mM Tris Cl (pH 6.8); 40% Glycerin; 0.05% SDS. Trenngel: 20% Acryl-/Bisacrylamid (29.1:0.9); 375 mM Tris Cl (pH 8.8); 8 M Urea; 5% Glycerin; 0.05% SDS. Die Trenngelstrecke betrug 37 mm. Zusammensetzung der Pufferstreifen: 0.2 M Tricine; 0.2 M Tris (pH 8.1); 0.55% SDS; 3% Agarose IEF. Die Silberanfärbung erfolgte nach Angaben von Pharmacia (Phastsystem: D.t.file Nr.210).

Die isoelektrische Fokussierung (IEF) erfolgte mit dem Phastsystem und käuflichen Polyacrylamidgelen (PhastGel IEF 3-9). Die Feldstärke betrug 500 Volt/cm, die Dauer 30 Minuten. Die Silberanfärbung erfolgte wie oben beschrieben.

Reinigung des Toxins. Es wurden jeweils 110 µl Spinnengift 10 Minuten bei 14'000 UPM zentrifugiert und der Überstand mit 60 mM Natriumacetat (pH 5.0) 1:1 verdünnt und auf eine Gelfiltrationssäule (Superdex 75, HR 10/30 Pharmacia; Flow 0.2 ml/min; HPLC-System Pharmacia) aufgetragen. Fraktionen, welche im Biotest Toxizität aufwiesen, wurden einzeln weiterverarbeitet. Sie wurden 1:1 mit A. bidest verdünnt und mit einer Mono S (HR 5/5 Pharmacia; Laufmittel A: 30 mM Natriumacetat (pH 5.0); B: 30 mM Natriumacetat (pH 5.0), 2 M NaCl, Flow 0.25 ml/min) einer Kationenaustauscherchromatographie unterzogen. Die erhaltenen Fraktionen wurden auf ein kleines Volumen eingeeengt (1-2 ml) und einer reversed phase-Chromatographie unterzogen (Nucleosil C4; Laufmittel A: 0.1% Trifluoressigsäure in A. bidest.; B: 99.9% Acetonitril, 0.1% Trifluoressigsäure, Flow 1 ml/min). Das erhaltene Toxin wurde mit SDS-Polyacryl-Gelelektrophorese sowie mit IEF auf seine Reinheit hin überprüft.

pH- und Ionenbestimmung. Der pH-Wert des Giftes wurde mit Merck pH Teststäbchen Nr. 9542 bestimmt. Die Natrium-, Kalium- und Calciumkonzentration wurde mit einem Atomabsorptionsspektrometer (Beckmann 1248) gemessen.

3. ERGEBNISSE UND DISKUSSION

Das gemolkene Gift adulter, weiblicher Spinnen weist einen Proteingehalt von 130-150 µg/µl auf. Der pH-Wert liegt bei 6.1. Für Natrium wurde eine Ionenkonzentration von 8.9 mM, für Kalium von 215.1 mM und für Calcium von 0.94 mM gemessen.

Die Anzahl der einzelnen Proteine lässt sich im SDS-Polyacrylamidgel (Abbildung 1) schlecht ermitteln, da es einige wenige, in geringer Konzentration vorkommende Proteine mit einem Molekulargewicht von ca. 31-100 kD und 6 stark angefärbte Hauptproteinbanden im Bereich von 2'500-31'000 D aufweist. In Abb. 3 zeigt das IEF-Gel (pH-Bereich 3 - 5) im basischen Bereich drei stark angefärbte Proteinbanden (pI

8.2, 8.3 und ca. 9.3) sowie ca. 6 schwach angefärbte Banden (pI zwischen 7 und 9.3). Die Mehrzahl der Proteine (5 stark angefärbte sowie 7 schwach angefärbte Banden) haben einen pI, der im sauren pH-Bereich zwischen pH 4.7 und 6.8 liegt. Nach einer Gelfiltration (Abbildung 1) wurden 5 Fraktionen (Nr. 15-19) mit letaler Wirkung im Protophormia-Biotest im Bereich von 6-14 kD identifiziert. Bei den übrigen Fraktionen liess sich in den vorhandenen Konzentrationen keine Toxizität nachweisen. Fraktion 1-10 und 25-41 zeigen zum Teil eine starke Absorption bei 215 nm auf, lassen sich aber nicht als Proteine im SDS-Acrylamidgel mit Silberanfärbung nachweisen.

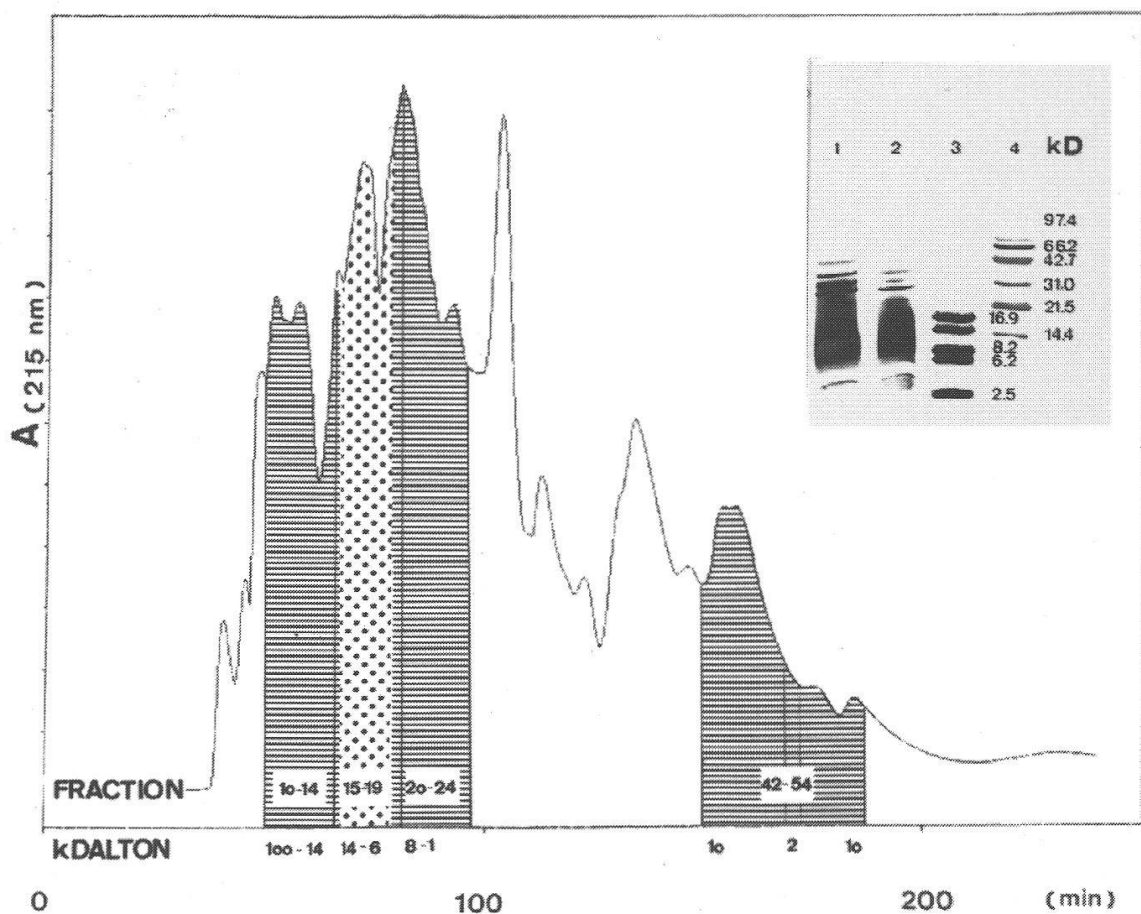


Abb.1. Gelfiltration des nativen Giftes von *Cupiennius salei* (Superdex 75, Pharmacia) Proteinfractionen sind schraffiert, im Biotest als toxisch erkannte Fraktionen sind punktiert. Polyacrylamidgel: Spur 1 und 2 natives Gift (1:20 und 1:50); Spur 3 und 4 Molekulargewichtsmarker (Pharmacia und Biorad).

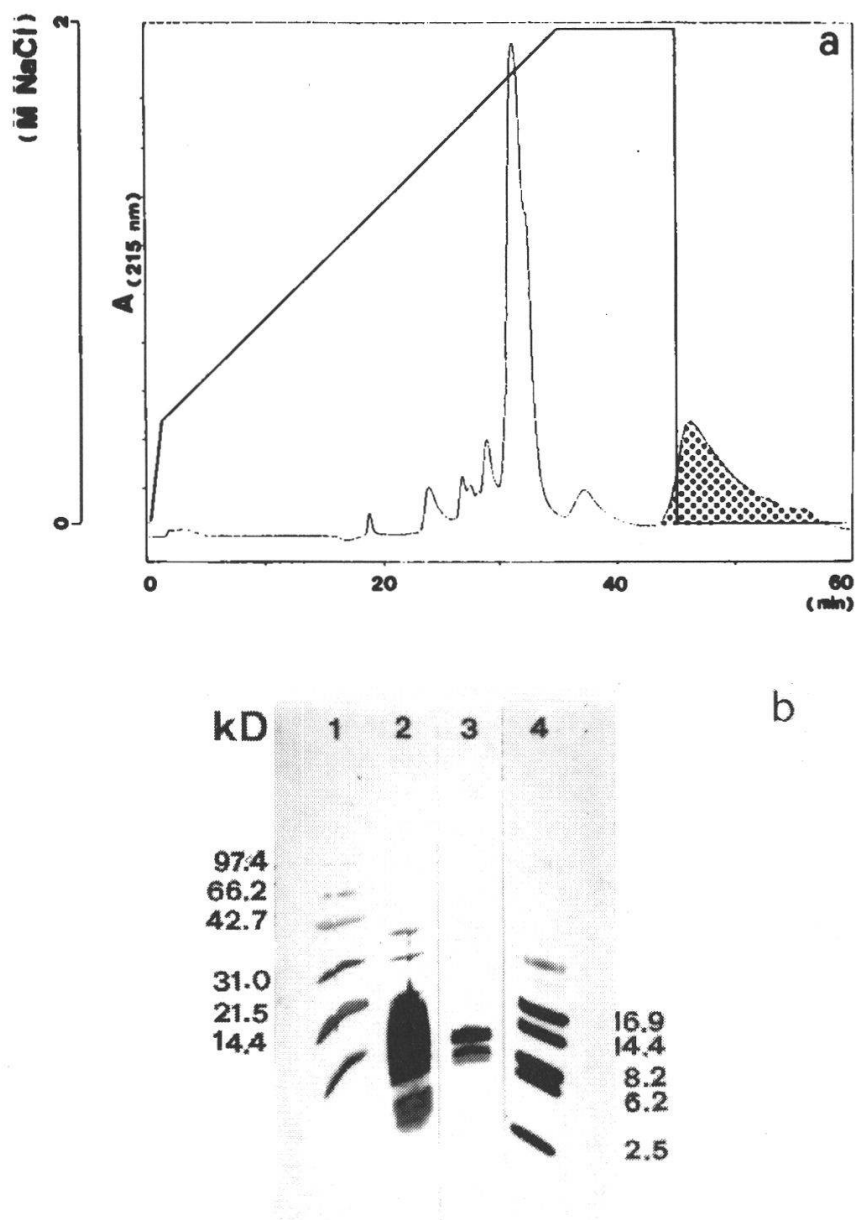


Abb. 2. Weitere Auftrennung der in Abb. 1 punktierten, toxischen Fraktionen. a: Kationenaustauscher-Chromatographie (Mono S, Pharmacia), punktiert ist die toxische Fraktion. b: SDS-Polyacrylamidgel: Spur 1 und 4 Molekulargewichtsmarker; Spur 2 natives Gift (1:20); Spur 3 durch Gelfiltration aufgetrennte Fraktion 16.

In einem nächsten Schritt wurden die Fraktionen mit der stärksten Giftwirkung (16-18) jeweils separat in einer Kationenaustauscherchromatographie aufgetrennt (Abbildung 2). Bei Fraktion 16, 17 und 18 zeigte jeweils nur der letzte Peak (punktiert) eine toxische Wirkung im Biotest. Die anderen Peaks sind, soweit durchgetestet, in diesen Konzentrationen nicht toxisch. Bei Fraktion 18 wurde bisher nur der markierte Peak untersucht und als toxisch identifiziert.

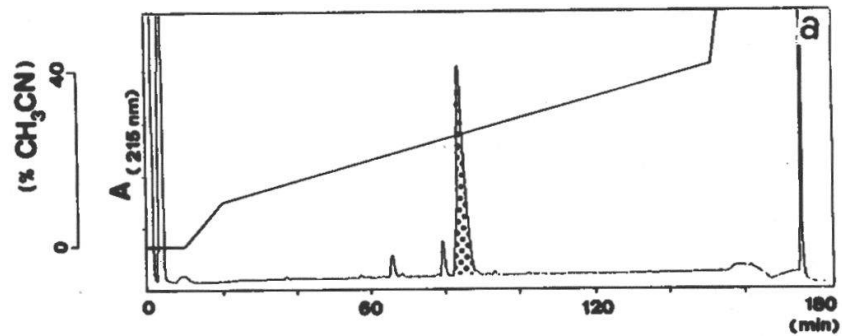
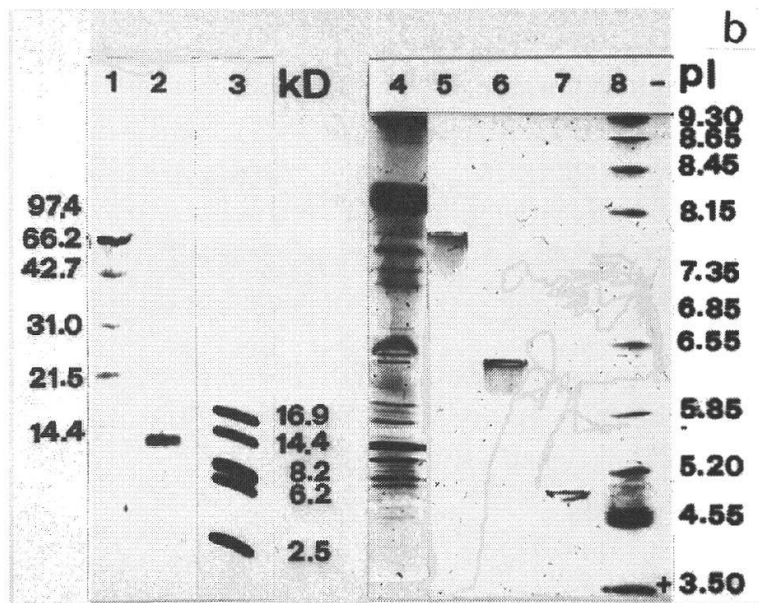


Abb. 3a: reversed Phase Chromatographie (Nucleosil C4 300, Machery und Nagel) der punktierten toxischen Fraktion von Abb. 2a. Die im Biotest als toxisch erkannte Fraktion ist punktiert. b: SDS-Polyacrylamidgel-Elektrophorese Spur 1 und 3 Molekulargewichtsmarker; Spur 2 gereinigtes CSTX; IEF-Gel Spur 4 natives Gift (1:15); Spur 5, 6, und 7 gereinigtes CSTX jeweils in der Nähe von Kathode, Anode bzw. der Mitte aufgetragen; Spur 8 pI-Standards (pH 3-9, Pharmacia).



Nach einer weiteren Reinigung der markierten Peaks von Fraktion 16-18 mit reversed phase HPLC (Abbildung 3) sowie der nicht markierten weiteren Peaks von Fraktion 16 und 17 zeigten wiederum nur die gekennzeichneten Fraktionen eine sofortige letale Giftwirkung im Biotest. Im SDS-Polyacrylamidgel erwiesen sich die drei markierten Einzelpicks nach reversed phase HPLC als ein einheitliches Protein (Abbildung 3b) von ca. 12 kD.

Dieses Protein stellt somit das erste bisher bekannte Toxin von *Cupiennius salei* dar (CSTX). Es weist in Abwesenheit bzw. Gegenwart von β -Mercaptoethanol keinen Unterschied im Molekulargewicht auf, besteht also nicht aus entsprechend auftrennbaren Untereinheiten. Das geschätzte Molekulargewicht im SDS-Polyacrylamidgel liegt bei 12 kD. Dies entspricht einer Größe von ca. 100 Aminosäuren.

Bisher sind Versuche, CSTX in einer 2D-Elektrophorese auf seine Reinheit hin weiter zu überprüfen, fehlgeschlagen, da es sich im IEF-Gel als sehr schwer löslich zeigt. An verschiedenen Bereichen (Kathode, Mitte und Anode) des IEF-Gels aufgetragen (Abbildung 3b), zeigt es ein Wanderverhalten zum sauren pH-Bereich hin. Wird das

Protein direkt im sauren pH-Bereich aufgetragen, ist es gänzlich unlöslich und verbleibt am Auftragungsort.

Diese Ergebnisse sind in mehrfacher Hinsicht bemerkenswert. Zum einen gelang es uns bisher, nur ein Toxin im Gift von *Cupiennius salei* zu identifizieren. In den meisten der wenigen bisher untersuchten Spinnengiften wurden jedoch mehrere Toxine nachgewiesen (z.B. ADAMS et al. 1989), die ontogenetische Veränderungen (MALLI & NENTWIG, dieser Band) oder beutetierspezifische Giftwirkungen (STUDER & NENTWIG, dieser Band) erklären können. Es kann also erwartet werden, dass noch weitere Toxine im Gift von *Cupiennius salei* gefunden werden. Zum anderen fällt CSTX durch sein Molekulargewicht von 12 kD im SDS-PAGE auf. Die meisten Spinnentoxine sind Polyamine (MG 400-800 D) oder kleinere Proteine von 4-6 kD. Lediglich von Theraphosiden und Ageleniden sind Toxine von bis zu 13 und 16 kD bekannt (PERRETT 1974, BOWERS et al. 1987). Das Toxin der einzigen untersuchten Ctenide *Phoneutria nigriventer* hat zwar ein geringeres MG von 5500-5900 D (ENTWISTLE et al. 1982), doch auch bei nah verwandten Arten sind deutlich unterschiedliche Toxinstrukturen bzw. Giftwirkungen möglich (NENTWIG et al. in press).

Danksagung: Wir danken S. Keller und R. Riechsteiner für vielfältige technische Unterstützung, Herrn Trusch (Abt. Prof. Schindler, Chemische Institute, Universität Bern) für die Ionenbestimmung und dem Schweizerischen Nationalfonds für finanzielle Unterstützung.

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Ecotone zones between forest islands and crop fields in the Masurian Lakeland, Poland, as barriers for migration of spiders to crop fields

par
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1. INTRODUCTION

The preliminary paper on forest islands in the agricultural landscape of Masuria (LUCZAK 1990) characterizes numbers, biomass, and age structure of spider communities. In the study of spiders living in the ecotones of forest islands (LUCZAK 1991), no species living exclusively in ecotones were found in the herb layer of forest islands, populations of many species occurred in forest ecotones and interiors throughout the growing season. There were differences in the dominant species between interiors and ecotones, also in their seasonal dynamics. The species showing preference either for ecotones or for interior of forest islands are listed.

The main purpose of the current work on forest islands is the analysis of relationships between the species of forest islands and the species of surrounding crop fields, separated by the zone of junction formed by the forest edge, structurally different from the forest interior with respect to the vegetation and microclimate (WOJCIK in print; Dabrowska-Prot, Luczak in print).

2. METHODS

In the present report the following "**variables**" are analysed in the herbaceous layer of six forest islands:

1. The number of species in forest islands, their ecotones and in the surrounding crop fields, their abundance, biomass and mean body weight.
2. Relative abundance of dominant species in the interior of forest islands, in ecotones, and in crop fields.

3. Percentage contribution of these groups of species to the total number of spiders in interiors and ecotones of the islands.
4. Abundance of species common to the interior and ecotone of forest islands, and to the ecotone and the surrounding crop field.

3. RESULTS

3.1 Concerning "Variable 1"

The six forest islands were inhabited by 35-49 species in inner parts and by 38-58 species in peripheral parts (forest ecotones). The surrounding crop fields were inhabited by only 16-30 species. Comparable samples collected with a sweep net and a quadrat frame contained more spiders from interiors of forest islands than from their ecotones, thus no edge effect was found for the whole group. The number of spiders collected in crop fields accounted for only 4%, 5.8%, and 6.8% of their numbers in ecotones. Similar proportions were found for the biomass of spiders. It should be noted, however, that epigean spiders are much more abundant in crop fields, and they are more important to this ecosystem (NYFFELER 1982).

Wood-lots dispersed in cropland can enrich crop fields with spiders (LUCZAK 1986; KRAUSE 1987), but in the landscape under study most species and individuals were retained within forest islands. Ecotones functioned as barriers to the dispersal of spiders into crop fields.

Mean body weight of spiders was higher in ecotones and interiors of forest islands than in crop fields, the last habitat being inhabited by smaller species and young forms. In 1989, the mean body weight of spiders was highest in ecotones (Tables I and II).

	Island n° 4			Island n° 5			Island n° 8		
	Inner part	Ecotone	Field	Inner part	Ecotone	Field	Inner part	Ecotone	Field
Number of species	49	58	29	45	49	16	48	52	30
General abundance (individuals)	1237	739	92	1423	646	87	1057	1180	112
%	60	35	5	66	30	4	45	50	5
Biomass mg w.w.	9739	6612	297	13686	6516	165	9583	14010	438
%	58	40	2	67	32	1	40	58	2
Mean weight of individual mg w.w.	7.87	8.95	3.23	9.62	10.10	1.90	9.07	11.87	3.91

Tab. I - Number of spiders, relatives abundance of spiders and their biomass /in mg w.w./ and weight of mean /statistical/ individual /in mg w.w./ - on Pino-Quercetum island /n° 4/ and on two birch-aspen islands /n° 5 and 8/ in their inner parts and marginal parts /ecotones/ and on neighbouring arable field. From 7 samples in the growing season 1989.

	Island n° 4			Island n° 6			Island n° 7		
	Inner part	Ecotone	Field	Inner part	Ecotone	Field	Inner part	Ecotone	Field
Number of species	44	56	21	35	38	21	40	48	27
General abundance (individuals)	1173	1199	46	1522	978	88	1586	1354	109
%	48	50	2	59	38	3	52	44	4
Biomass mg w.w.	7607	6454	204	11735	8501	358	10936	9248	369
%	53	45	2	57	41	2	53	45	2
Mean weight of individual mg w.w.	6.48	5.38	4.43	7.71	8.69	4.07	6.89	6.83	3.38

Tab. II - Number of spiders, relative abundance of spiders and their biomass /in mg w.w./ and weight of mean /statistical/ individual /in mg w.w./ .- on Pino-Quercetum island /n° 4/ and on two birch-aspen islands /n° 6 and 7/ in their inner parts and marginal parts /ecotones/ and on neighbouring arable field. From 7 samples in the growing season 1989.

3.2 Concerning "Variable 2"

The species living in inner parts of forest islands in the Masurian Lakeland consisted of *Meta segmentata*, *Linyphia triangularis*, *Linyphia montana*, *Gongylidium rufipes*, *Bolyphantes alticeps*, and *Helophora insignis* (Table III). All of them were abundant or rather abundant. The first two were the main dominants. The species of the forest

Forest islands	Pino-Quercetum				Birch-aspen								M		Total
	4		4		5		6		7		8		I	E	
Species	I	E	I	E	I	E	I	E	I	E	I	E	I	E	Total
Meta Segmentata	246	75	123	52	122	44	141	26	112	68	95	108	839	373	1212
Linyphia triangularis	216	120	250	130	251	36	125	41	204	111	165	165	1212	603	1815
Linyphia montana	14	16	18	7	38	5	93	9	117	94	61	28	341	159	500
Gongylidium rufipes	186	160	194	47	226	49	201	21	363	180	98	57	1268	514	1782
Bolyphantes alticeps	26	4	9	3	3	1	62	10	43	33	24	6	167	57	224
Helophora insignis	16		16		110		73		26		3		244	0	244

Table III. Relative abundance of species preferring inner part of forest islands. I - inner part E - ecotone

island interiors belonged to two families, Metidae- one species, and Linyphiidae s.l. - five species.

The species showing preference for edges of forest islands comprised *Tetragnatha extensa*, *Araneus cucurbitinus*, *Araneus patagiatus*, *Linyphia pusilla*, *Neottiura bimaculata*, *Philodromus aureolus*, *Xysticus ulmi*, and *Tibellus oblongus* (Table IV). They represent five families.

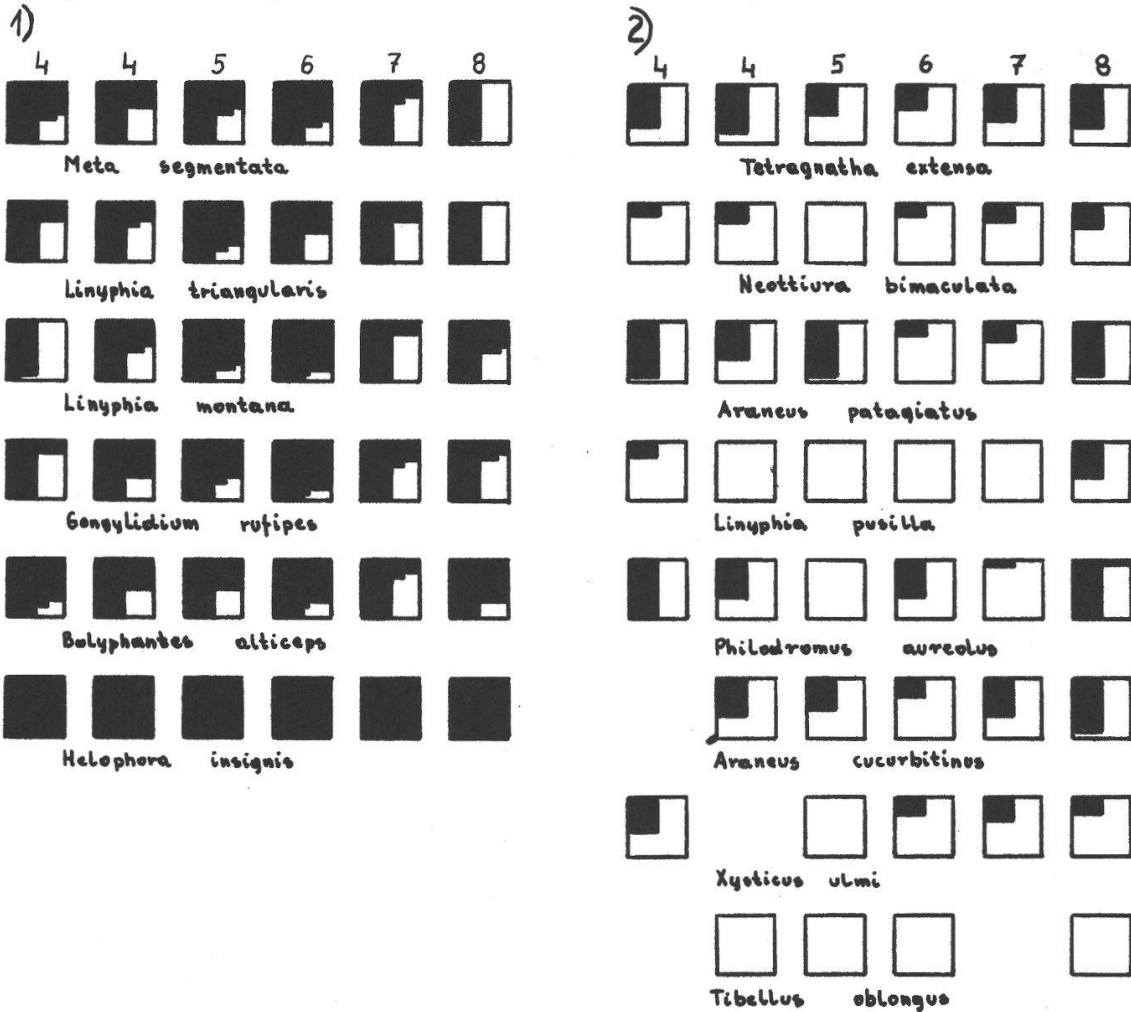
	Pino-Quercetum				Birch-aspen								M		
Forest islands	4		4		5		6		7		8				
Species	I	E	I	E	I	E	I	E	I	E	I	E	I	E	Total
Araneus cucurbitinus			4	10	9	9	3	12	6	16	10	12	28	67	95
Araneus patagiatus	8	10	10	26	2	6	2	27	5	33	23	28	53	128	181
Tetragnatha extensa	53	95	29	40	12	52	13	82	17	52	40	73	164	394	558
Microlinyphia pusilla	1	8	0	2	0	3	0	2	0	5	2	5	3	25	28
Neottiura bimaculata	6	51	6	42	0	12	1	21	1	9	16	65	30	200	230
Philodromus aureolus	5	7	6	15	0	14	4	11	4	48	26	25	45	118	163
Xysticus ulmi	3	7	0	0	0	6	3	24	4	21	2	15	12	73	85
Tibellus oblongus	0	0	0	4	0	8	0	4	0	0	0	20	0	36	

Table IV: Relative abundance of species preferring marginal part of forest islands /ecotones/ I - inner part E - ecotone

3.3 Concerning "variable 3"

The percentage contribution of spiders occurring in inner and marginal parts of forest islands to the total number of spiders in the forest islands is shown in figure 1. With few exceptions, a clear pattern can be seen for all the islands: higher densities of spider populations either in interiors or in ecotones. Only in the smallest island (no 8), 0.125 ha in size, which can be treated as an ecotone as a whole, the proportions of some species in inner and peripheral parts were different than on the other islands. This was the case of two species of the interior, *M. segmentata* and *L. triangularis*, both dominants, and of ecotone species such as *N. bimaculata*, *L. pusilla*, and *A. cucurbitinus*. In the preliminary paper on forest islands (LUCZAK 1990) and in the detailed paper (LUCZAK, in print) there is information that the density of spiders was lowest on the smallest 0.125 ha island. On all the other forest islands (35 ha, 13 ha, 1.5 ha, 0.5 ha, 0.5 ha, 0.5 ha), total densities of spiders were not correlated with the sizes of islands, and they were rather similar. The different distribution of some spider species on the smallest forest island was a consequence of differences in ecological conditions as compared with those on all the other islands.

Spider species preferring interior (1) and species preferring ecotone (2)
of forest islands



No pattern was found for population densities in interiors or ecotones for *Tetragnatha montana*, *Pachygnatha listeri*, and *Enoplognatha ovata*. They reached higher densities sometimes in inner parts of the islands, sometimes in ecotones, or they had similar densities in both these habitat types. They were less susceptible to differences in ecological conditions of ecotones and interiors of forest islands. It has been found, however, that e.g. *E. ovata* reproduces more abundantly in ecotones (TARWIP, in print, TARWID and LUCZAK, in prep.).

3.4 Concerning "variable 4"

In total, 110 species have been recorded over the two study years. The number of species occurring in both the interiors and the ecotones of forest islands ranged from 20 to 29 out of 57-70 species in all the habitat types (island interior, forest ecotone, and cropfields). The species sharing the ecotone and interior of forest islands accounted for 83-92% of the number of spiders in the interiors, and for 80-90% of the number of spiders in the ecotones of forest islands.

The number of species occurring in both the forest ecotones and the surrounding crop fields ranged from 8 to 22, the total number of species in these two habitat types being 57-70. They accounted for 57-73% of the total number of spiders in the ecotones and for 65-83% of the total number of spiders in the crop fields.

The species occurring on only in one, two, or three islands, and the species occurring only one year were numerous, but they were represented by a small number of individuals. These were species from other layers of the ecosystems and rare species.

4. CONCLUSIONS

1. The number of spiders species was higher in ecotones than in interiors of forest islands (Tables I and II).
2. The highest numbers and biomass of spiders occurred in interiors of forest islands, lower in ecotones, and the lowest (minute) in cropfields (Tables I and II).
3. Mean body weight of spiders in ecotones and interiors of forest islands were much higher than in crop fields, where mostly small species and young forms occurred (Tables I and II).
4. Among the abundant species, 6 had higher population densities in interiors of forest islands, 8 had higher densities in ecotones, and 3 species did not show any preference (Tables III and IV, figure 1).
5. The species occurring in both the interiors of forest islands and their ecotones accounted for as many as 80-92% of the total number of species collected from individual forest islands.
6. Spider communities of the inner and marginal parts of forest islands differed in relative numbers and in densities of individual species, but the proportions of species common to the total community of spiders on forest islands were similar (80-92%), and also the species composition was similar
7. Crop fields were characterized by a considerably lower number of species, and by very low numbers and biomass of spiders in the field layer. In this landscape and habitat configuration, ecotone is a barrier precluding dispersal of many spider species from forest islands to crop fields.

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Ontogenetische Aspekte der Giftdrüsen und des Giftes von *Cupiennius salei* (Araneae: Ctenidae)

par
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Summary: The protein content of the venom of *Cupiennius salei* increases from instar 6 to instar 11 (adults) continuously. Juvenile and adult spiders have a very active venom (LD-50 biotest with crickets), its toxicity, however, decreases from instar 6 to 10 by 60 %. After injections of sublethal venom doses into crickets, respirometric analyses of the venomous effect show different physiological responses for venoms from different spider instars and from both sexes. This leads to the assumption of instar-specific and sex-specific components in the venom of *Cupiennius salei*.

1. EINLEITUNG

Vor allem in der pharmakologischen und neurophysiologischen Forschung erfährt Spinnengift ein zunehmendes Interesse, dass sich allerdings weitgehend auf wenige Arten beschränkt. Meist wird das Gift adulter Tiere untersucht und mögliche Veränderungen während der Ontogenese der Spinnen bleiben ausser Betracht. Die mit Gift in Zusammenhang stehenden ontogenetischen Untersuchungen bleiben bis heute auf einige histologische Vergleiche des Giftdrüsenapparates (z.B. MILLOT 1931) beschränkt. Kenntnisse über die Entwicklung des eigentlichen Giftes fehlen hingegen fast vollständig. Mit der vorliegenden Arbeit soll am Beispiel der mittelamerikanischen Ctenide *Cupiennius salei* die Ontogenese des Giftes und des Giftdrüsen näher beschrieben werden.

2. MATERIAL UND METHODE

Cupiennius salei (Ctenidae) ist eine Kammspinne, die mit den Untersuchungen von MELCHERS (1963) als Labortier eingeführt wurde und inzwischen sehr gut untersucht ist. Unsere Tiere werden in einer Dauerzucht bei 25°C je nach Grösse in Kunststoffbehältern oder Gläsern einzeln gehalten. Regelmässiges Befeuchten des Gipsbodens führt zu einer relativen Luftfeuchtigkeit von ca. 70%. Bei wöchentlicher Fütterung mit Heimchen (*Acheta domesticus*) wurden etwa 95 % der Tiere im 11. Stadium adult, 5 % im 12. Stadium. Insgesamt stand eine Versuchsgruppe von mehreren 100 Tieren zur Verfügung, der regelmässig Individuen zur Sektion oder Giftgewinnung entnommen wurden.

Bedingt durch die Grösse der Spinnen, konnte erst ab dem 6. Stadium Gift gewonnen werden. Hierzu wurde das Tier mit CO₂ betäubt und elektrisch gemolken. Die Giftabgabe erfolgte in Mikrokapillaren, die zuvor über die Chelicerenklau e gestülpt wurden. Die Giftaufbewahrung geschah bei -80°C. Jedes Tier wurde nur einmal pro Stadium gemolken, adulte Tiere nur bis 3 Monate nach der Adulthäutung. Die Proteinbestimmung erfolgte mit gepooltem Gift.

Für die Bestimmung der Giftwirkung wurde das Gift mit Insektenringer in verschiedene Konzentrationen verdünnt und bei CO₂-betäubten Heimchen von 110±10 mg Körpergewicht in die Gelenkmembran zwischen Coxa und Trochanter des rechten Vorderbeines injiziert. Der Berechnung der LD-50 liegen Versuchsserien in 4 Giftkonzentrationen (je 0,6 µl Volumen, je 60-80 Heimchen) während 24 h zugrunde, der Kontrollgruppe wurde Insektenringer gespritzt. Diese Methode wurde durch eine respirometrische Untersuchung ergänzt, bei der deutlich subletale Dosen von Gift injiziert wurden und die CO₂-Produktion über 640 Minuten optoakustisch gemessen wurde. Diese Methode und die Verrechnung ihrer Ergebnisse sind ausführlich bei STUDER & NENTWIG (dieser Band) und STUDER (1991) beschrieben.

3. ERGEBNISSE UND DISKUSSION

Die Länge von Tibia I und des Prosomas nimmt bei *Cupiennius salei* über alle Entwicklungsstadien kontinuierlich zu. Die Überlappung ist so gering, dass fast alle Individuen aufgrund dieser Masse eindeutig einem Stadium zugeordnet werden können. Erst in den letzten Stadien unterscheiden sich die beiden Geschlechter (Abbildung 1). Die Giftdrüsen bestehen aus drei Abschnitten: der Ampulle (einer karottenförmigen Verbreiterung des Ausführkanals in der Giftklaue), einem Verbindungskanal und der Hauptdrüse (Abbildung 2). Während in der Hauptdrüse das Gift sekretiert wird, könnte es sich bei der Ampulle um einen Speicher handeln, in dem sich die jeweils einspritzbereite Giftmenge befindet. Ein Vergleich der benötigten Giftmengen für Heimchen oder andere Insekten (FRIEDEL & NENTWIG 1989) zeigt denn auch stadienspezifisch eine gute Übereinstimmung mit dem Volumen der Ampulle.

Die Morphologie der Giftdrüse bleibt im Verlauf der Ontogenie der Spinnen im wesentlichen unverändert, die anatomische Lage der Drüse verändert sich jedoch (Abbildung 2). Die Hauptdrüse wächst tiefer in das Prosoma und nimmt hier schliesslich einen grossen Teil ein. Im Unterschied zu Angaben bei MILLOT (1931) reicht jedoch auch beim 1. Stadium die Hauptdrüse schon zur Hälfte aus den Cheliceren heraus und dringt in das Prosoma vor. Die Giftdrüsenentwicklung innerhalb der labidognathen Spinnen ist also offensichtlich nicht so einheitlich, wie sie MILLOT aufgrund seiner Untersuchungen an Scytodidae und Thomisidae annahm.

Während der Ontogenese findet mit jeder Häutung bis zum 11. Stadium jeweils fast eine Verdoppelung des Drüsenvolumens statt (Abbildung 3). Männchen haben durchwegs ein kleineres Drüsenvolumen (max. 8,7 μ l) als Weibchen (12,3 μ l). Die Menge gemolkenen Giftes lag durchschnittlich (N=80) für das 6. Stadium bei 0,25 μ l/Drüse, für das 9. Stadium bei 1,7 μ l und für adulte Tiere bei 3,0 (Männchen) bzw. 5,6 μ l (Weibchen). Dieser Melkertrag machte für die Stadien 6-8 70-90% des Drüsenvolumens aus, für die Stadien 9-10 40-50% und für adulte Tiere um 40 %.

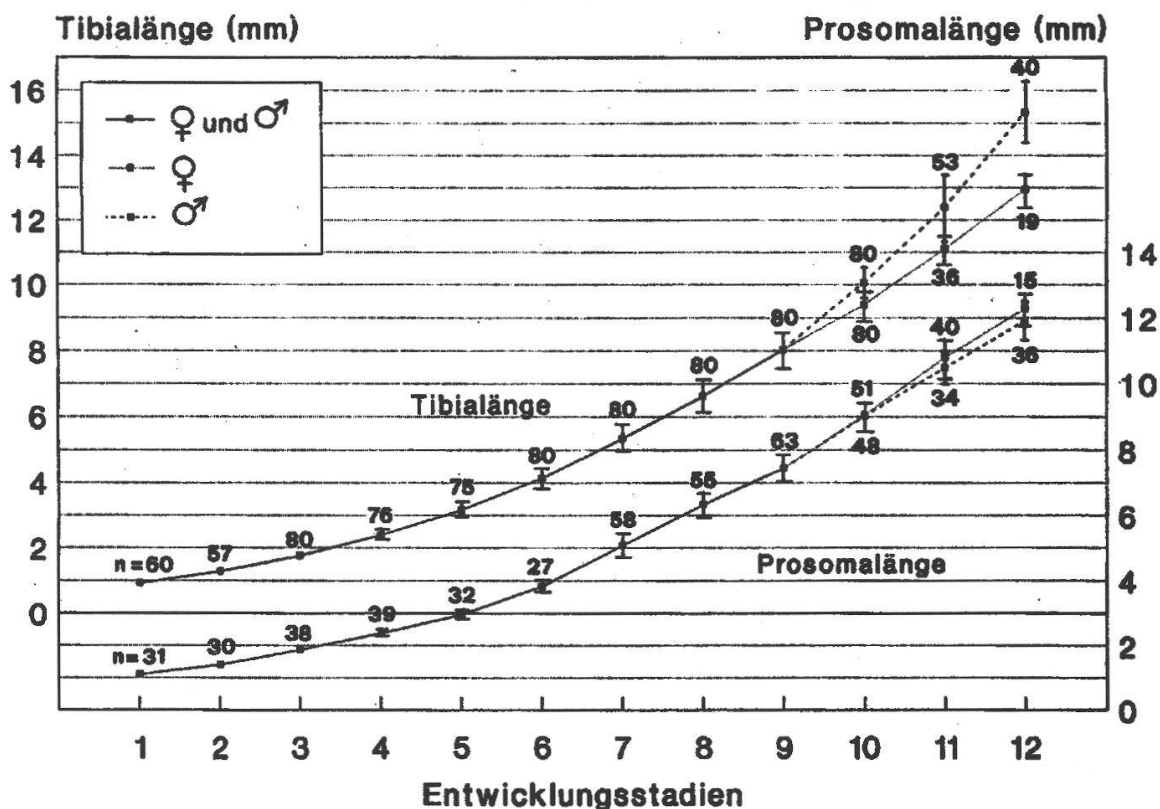


Abb. 1. - Morphologische Entwicklung von Tibia und Prosoma im Verlauf der Ontogenese.

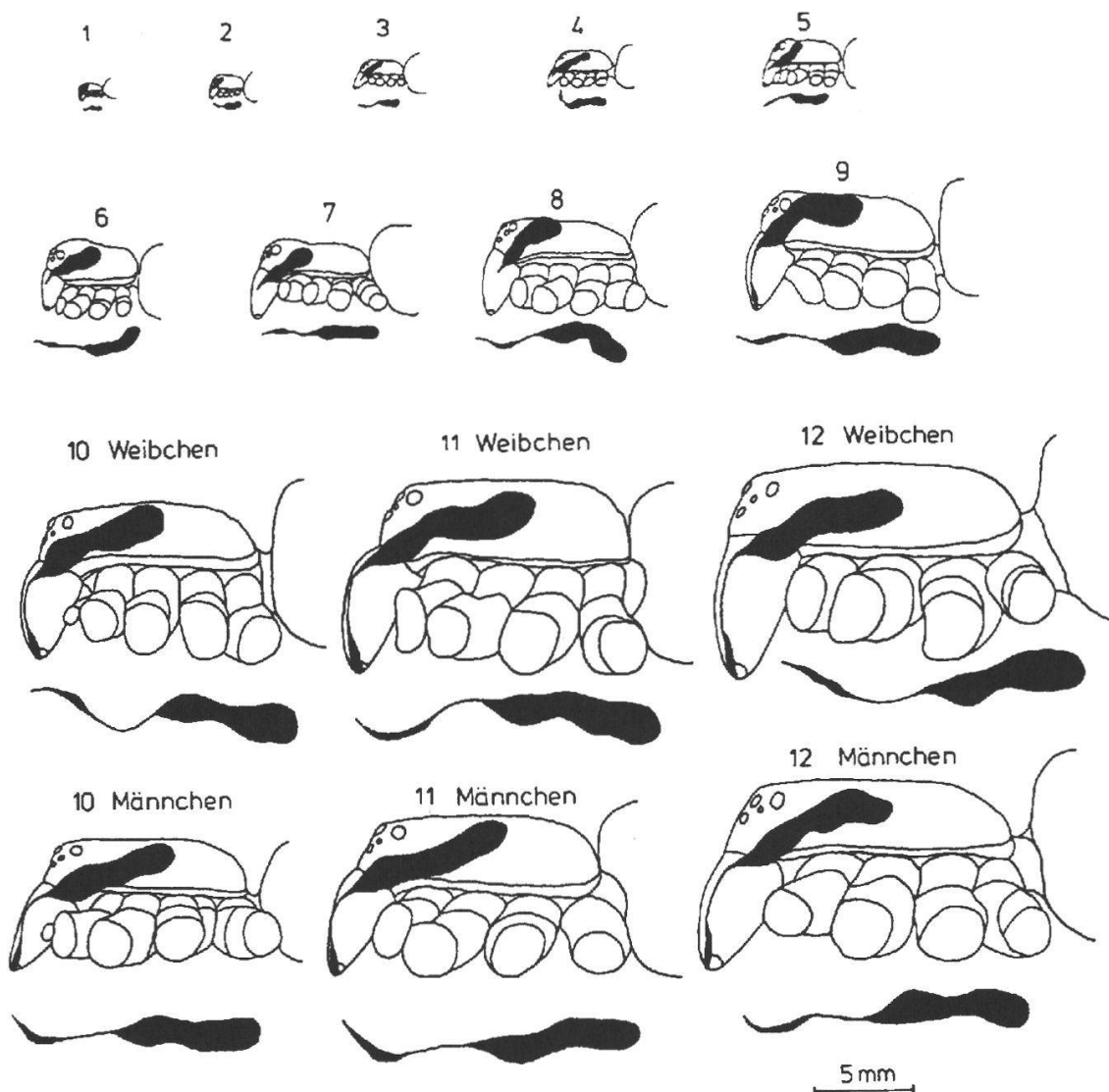


Abb. 2. - Relative Grösse und Lage der Giftdrüsen für die Entwicklungsstadien 1 - 12.

Der Proteingehalt des Spinnengiftes steigt im Verlauf der Ontogenese stetig an (Abbildung 4). Er beträgt im 6. Stadium ca. $100 \mu\text{g}/\mu\text{l}$ und ist bei adulten Tieren rund 50 % höher. Männchen haben im allgemeinen einen geringfügig niedrigeren Proteingehalt als Weibchen. Die Toxizität des Giftes verändert sich ähnlich stark, jedoch nicht gleichmässig. Juvenile Tiere im 6. Stadium und adulte Tiere (11. Stadium) haben ein sehr stark wirkendes Gift (niedrige LD-50). Während der Entwicklung der Tiere erhöht sich jedoch die LD-50 um fast 60 %, so dass subadulte Spinnen im 10. Stadium ein relativ wenig toxisches Gift haben. Das Gift von Weibchen ist stets wirksamer als das von Männchen (im 12. Stadium 35 %). Von Spinnen der ersten 5 Entwicklungsstadien konnte kein Gift gewonnen werden. Die vorliegenden Ergebnisse lassen jedoch die Annahme zu, dass ihr Gift noch toxischer als das der älteren Stadien

ist. Möglicherweise verfügen Jungspinnen im Verlauf der Ontogenese generell über das wirksamste Gift. Wegen der grossen technischen Schwierigkeiten ist es bis heute jedoch noch nicht gelungen, bei sehr kleinen Spinnen Gift durch Melken zu gewinnen. Die respirometrische Analyse der Giftwirkung zeigt in allen Fällen einen ausgeprägten Abfall der CO_2 -Produktion in den ersten 60 Minuten nach der Giftinjektion. Im weiteren Verlauf nehmen die Kurven annähernd linear ab. Die Kurvenverläufe des 8. und 9. Stadiums sind nahezu identisch, liegen aber tendenziell höher als die des 7. Stadiums. Das Gift des 10. Stadiums wirkt weniger stark als das adulter Tiere, welches den deutlichsten Respirationsabfall verursachte. Im 11. Stadium wirkt das Gift der Männchen anfangs sehr rasch, um nach 200 Minuten einen linearen Verlauf zu nehmen. Das Gift der Weibchen bewirkt hingegen einen langsameren, jedoch länger andauernden Abfall der CO_2 -Produktion, so dass diese Kurve nach 180 Minuten unter die der Männchen zu liegen kommt.

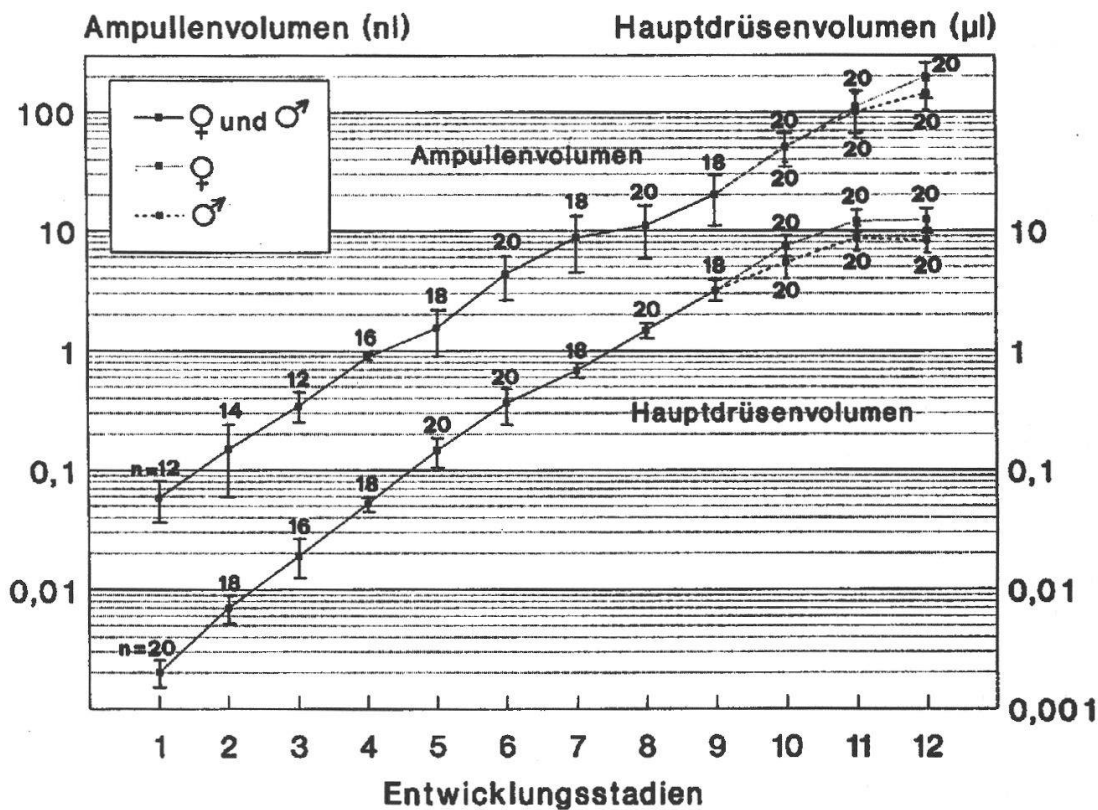
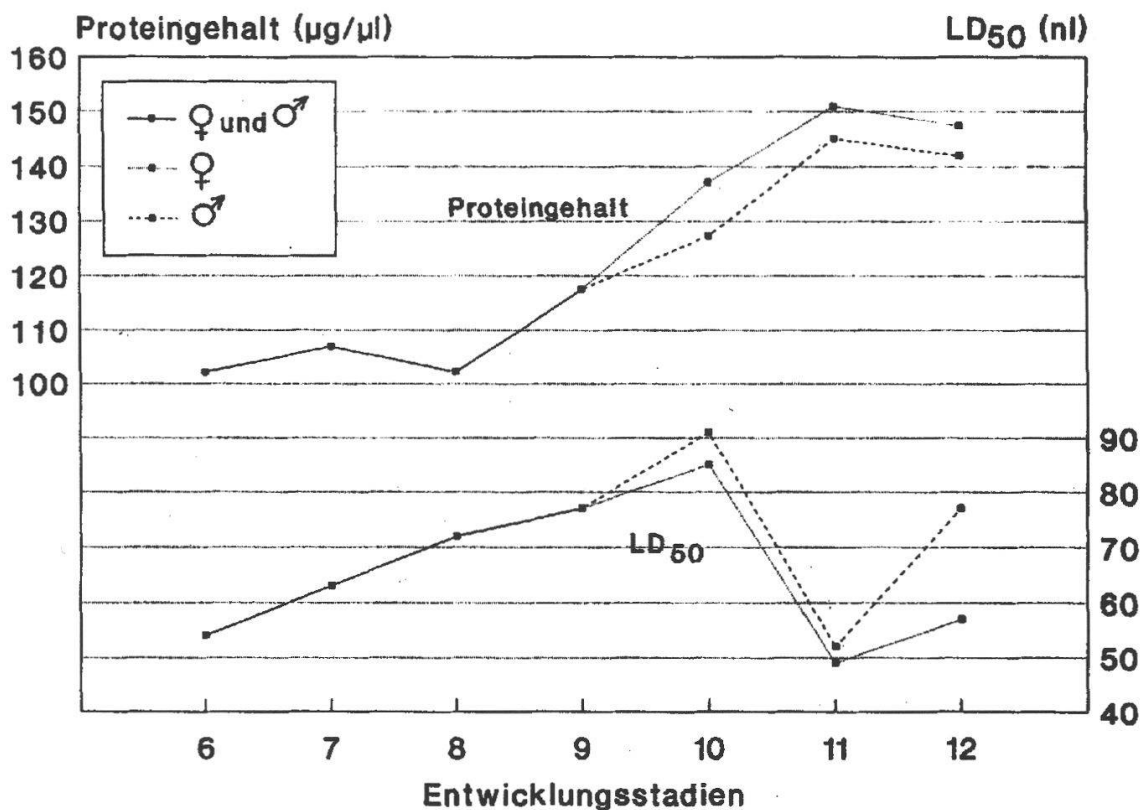


Abb. 3 - Volumenentwicklung von Hauptdrüse und Ampulle im Verlauf der Ontogenese.



3Abb. 4. - LD-50 Werte für das Gift von *Cupiennius salei* bei *Acheta domestica* und Proteingehalt des Giftes der Stadien 6 - 12. Bei den Stadien 6 - 9 wurde nicht zwischen Männchen und Weibchen unterschieden.

Eine weitergehende, regressionsanalytische Beurteilung verschiedener Koeffizienten der respirometrisch gewonnenen Kurvenverläufe zeigt vor allem im Zeitverlauf deutliche Unterschiede zwischen den einzelnen Stadien und Geschlechtern auf, die die LD-50 Werte sehr gut ergänzen (MALLI 1991). Biochemisch bedeutet dies, dass das Gift von *Cupiennius salei* aus mehreren Komponenten besteht, deren Mengen und relative Anteile ontogenetischen Veränderungen unterliegen. Die Annahme eines speziellen "Juvenilttoxins" kann z.B. erklären, wieso trotz bedeutend niedrigerem Proteingehalt das 6. Stadium über ein viel wirkungsvolleres Gift verfügt als das 10. Stadiumen. Diese Annahme deckt sich auch mit neueren Arbeiten v.a. an Ageleniden und Araneiden, die (wenn auch von adulten Tieren) 2-3 unterschiedliche Klassen von Toxinen im Spinnengift nachwiesen (z.B. ADAMS et al. 1989).

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Interspecific and intraspecific interactions between spider species from apple orchards

par
Patrick Marc

Summary: The intraspecific and interspecific predation between some spider species listed in apple orchards *Anyphaena accentuata*, *Diaea dorsata*, *Philodromus cespitum* has been studied. It has been shown that even in extreme conditions this predation is low. An analysis with a video recording system completes the study concerning *Anyphaena accentuata*. It is demonstrated that there are interactions limiting cannibalism during encounters and also some avoidance phenomena of individuals that suggest, in this wandering nocturnal spider, a distance recognition.

1. INTRODUCTION

It is generally admitted that there is high intraspecific and interspecific predation between spider species (BRISTOWE 1958; GREENSTONE 1978). However, there are only few studies on the subject, in addition most of them concern web-spider species (RIECHERT 1984; RYPSTRA 1986; SPILLER 1986) or diurnal species of the Lycosidae and Salticidae families (EDGAR 1969; NOSSEK & ROVNER 1984; JACKSON 1982). EDGAR (1969) finds 24,4% of cannibalism in the lycosid spider *Pardosa lugubris* and HALLANDER (1970) confirms in other *Pardosa* species that this kind of predation occurs frequently. Nevertheless, KRAFFT (1975) indicates that in *Pardosa* and *Lycosa rabida* there are interactions limiting the cannibalism like "legs raising" and NOSSEK and ROVNER (1984) demonstrated that cannibalism was uncommon (<1%) between conspecific groups as well as heterospecific groups of the spider species *Lycosa punctulata*, *L. rabida* and *L. huello*.

In the case of a biological control with Araneids in orchards, the resort to releases of

spiders (MARC 1989), will strongly increase their density. A high cannibalism will then reduce their efficiency, that is why emphasis has been laid on this aspect of predation. The study has been carried out on three species listed from apple orchards (MARC unpubl. data): *Anyphaena accentuata*, *Diaea dorsata* and *Philodromus cespitum*.

2. MATERIAL AND METHODS

For the general analysis, about eight hundred spiders of these three species were collected on deciduous trees by beating the low branches. Spiders were placed individually in micro-tubes (Ependorff). In the laboratory, after corroboration of the identification of the smaller individuals, the Araneids were left in natural photoperiod, in ambient temperature and without any food for five days. The fifth day, all individuals were weighed. The spiders that were harmed during the collection were kept out of the experiment because they were vulnerable. The others were laid two by two in Petri boxes (9 cm diameter and 1,5 cm high) between 18 and 19.30hrs. A high moisture was maintained in each enclosure with a damp wad of cotton disposed so that no shelter was available. The enclosures were controlled twice a day during a week and cannibalism cases noted. All the spiders captured were used for only one experiment.

For a more precise analysis of the agonistic interactions, a study was carried out with video equipment comprising :

- a black and white camera with a "Newicon" tube (HV 735) sensitive to weak red light with a wavelength between 6300 and 7500 Å, and a 12,5 mm/ 1,3 lens, with a minimum foca/distance of 0,3 m ;
- a black and white monitor (VM 906) ;
- a Panasonic AG 6015 video recorder equipped with several recording speeds (from 25 to 1 shots per sec), corresponding recording periods (3 to 72 h), and a timer.

Each spider was placed in a plastic box (10 x 8 x 1 cm), the outer sides of which were covered with yellow paper, to obtain better contrast and to prevent individual spiders from seeing each other. The paper was squared in centimeters. A high moisture was maintained in each box with a damp wad of cotton. A plexiglass lid was used to shut each enclosure. Three boxes were placed in the camera field and isolated from their stand, and the apparatus placed in a room apart from that in which the video recordings were analysed, in order to avoid vibrations. The experiments were carried out under natural photoperiod conditions, although a constant red light was necessary for night filming. Temperature and brightness were recorded throughout the experiments. The video recorder was programmed to take six pictures per second. Because the present work was carried out on animals with rapid movements the time needed to analyse the recording was quite lengthy, limiting the number of circadian periods which could be studied. In the analysis of each circadian period, the beginning and the end of locomotory activity, the time when encounters and avoidances occurred was noted, as

well as the distances covered by the spiders. The activity was compared to the photoperiod (Greenwich Mean Time was used in the results). Four females and two juveniles of *Anyphaena accentuata* were studied in these experiments, during 96 hours. These individuals were in the same conditions as those of the previous experiments. The weight ratio was 1.

3. RESULTS

3.1 General analysis

The three species have been studied by pairs. Only the figures relating to the species *Anyphaena accentuata* are presented here. Concerning the intraspecific predation, the cannibalism cases occur when the weight ratio of the individuals is above 4 (figure 1). Then it occurs rapidly, in the first fifteen hours after the beginning of the experiment. The same type of results is obtained with both other studied species.

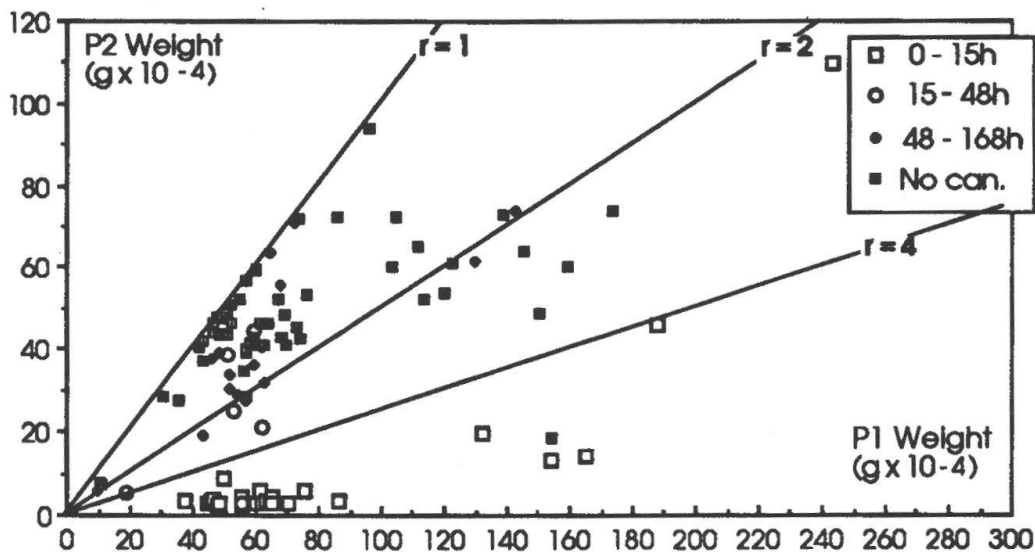


Fig. 1 - Time and weight related intraspecific predation in *Anyphaena accentuata*. The different symbols indicate the time when cannibalism occurs. The black squares showing the absence of cannibalism after a week. Three ratios of weight between individuals (1, 2 and 4) are materialized by continuous lines.

The results of the study of the interspecific predation do not show more cannibalism cases in these species (figures 2a-b). Only scarce cases are to be noted when the weight ratio is below 4. The experiments in *Philodromus cespitum* and *Diaea dorsata* produce the same results.

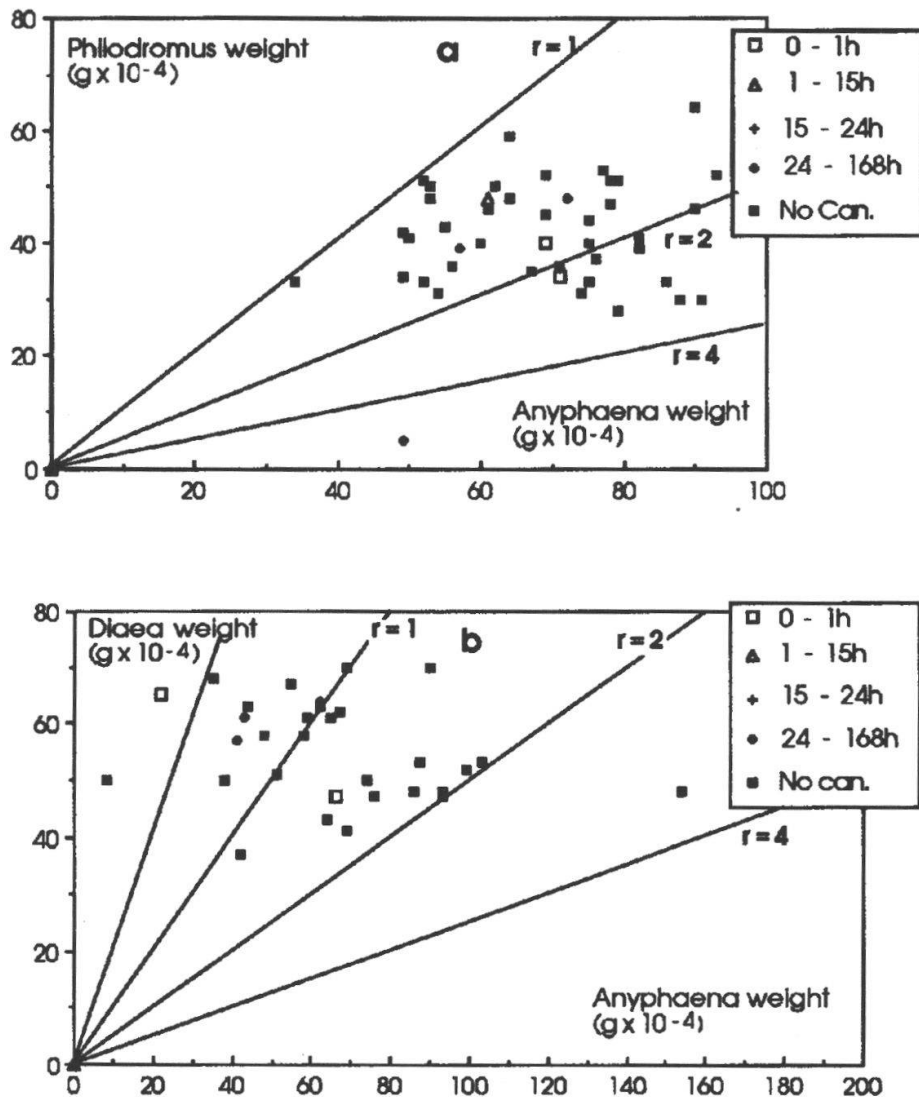


Fig. 2 a-b : Time and weight related interspecific predation between *Anyphaena accentuata* - *Philodromus cespitum* (a) and *Anyphaena accentuata* - *Diaea dorsata* (b).

3.2 Videographic analysis

To know if the low occurrence of intraspecific and interspecific predation obtained in the previous experiment is not due to an artificial lack of locomotory activity in the enclosures, the analysis of video recorded documents has been carried out and the results concerning *Anyphaena accentuata* are given.

The locomotory activity of this species and the photoperiod synchronize. The beginning of this activity coincides with the minimal light intensity recorded and lasts all night until the increase of light intensity in the morning (figures 3a and 3c). There is a peak of locomotory activity during the first third hours of the night.

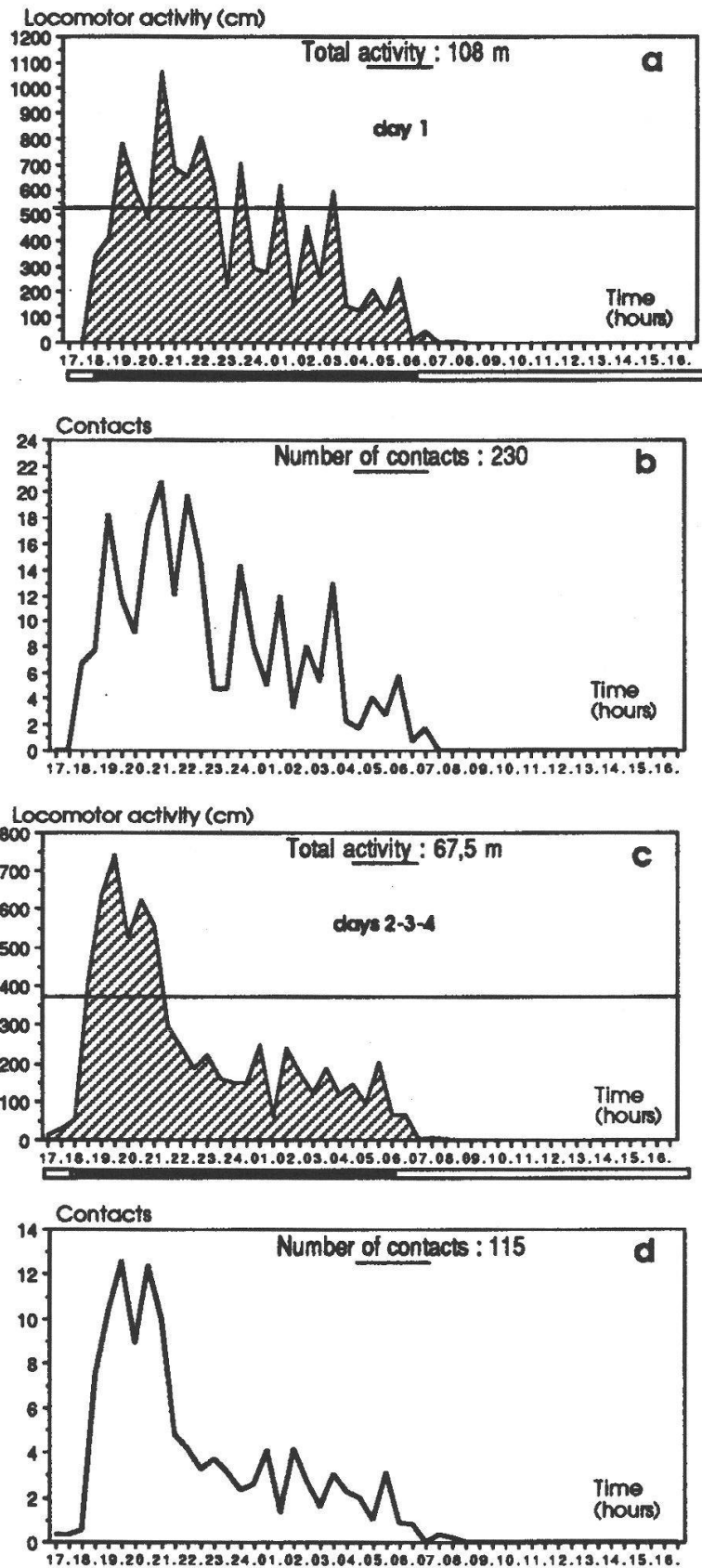


Fig. 3 a-d - Daily locomotory activity and agonistic behaviour in *Anyphaena accentuata*. a and b during the first circadian period (n=3), c and d during the last three circadian periods (n=3). The average total distance covered during a circadian period corresponds to a pair of individuals in the same enclosure.

The spiders covered an average of 108 meters during the first circadian period, the locomotory activity decreased to 67,5 meters during the last three days of the experiment (figures 3a, 3c and 4a). The graph of the number of contacts for the different circadian periods show the same aspect as the locomotory activity graph (figures 3b, 3d and 4a). The number of contacts during the first day of the experiment is on an average of 230, it decreased afterwards to 115.

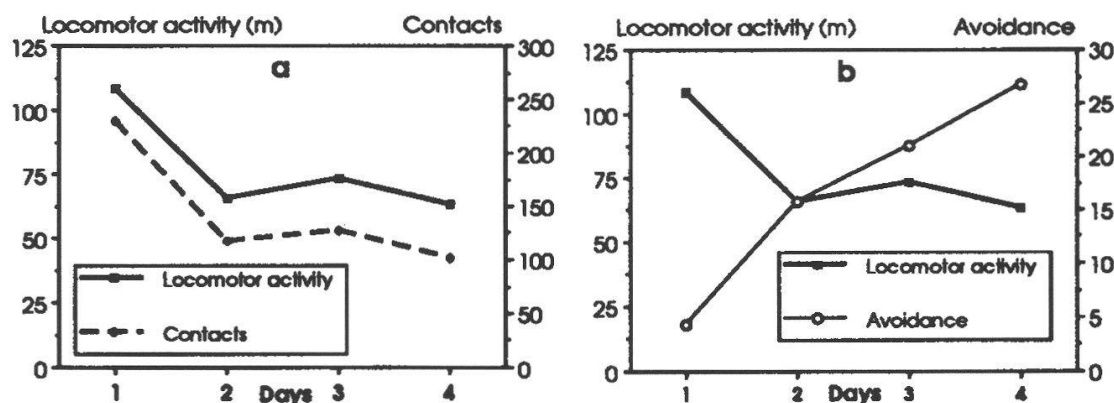


Fig 4 a-b - Time related locomotory activity and agonistic behaviour of contact (a) and of avoidance (b) in *Anyphaena accentuata*.

The number of avoidances increased as the experiment progressed (figure 4b).

The ratio of the number of contacts and the distances covered by a pair of spiders decreases during the four days of the experiment (figure 5). However, the ratio of the number of contacts added to the avoidances number and the distances covered by a pair of spiders decreases only between the first day and the second day of the experiment and becomes stable afterwards (figure 5).

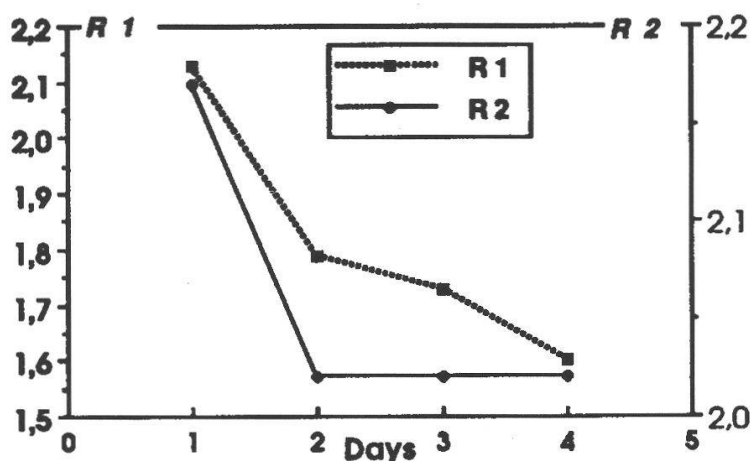


Fig. 5 - Time related agonistic behaviour in *Anyphaena accentuata*. R1, ratio of the number of contacts and locomotory activity (in meters); R2, ratio of the number of contacts added to the number of avoidances and the locomotory activity.

4. DISCUSSION - CONCLUSIONS

An easy method of investigating intraspecific and interspecific predation in non web-spiders was set up to point out the species with high rate of cannibalism. As these species can not be used in biological control. In addition, it is important to know if, among the species that are most numerous in the agrosystem, such a species is present.

Concerning apple orchards, in general, the results seem to be encouraging because the intraspecific predation cases are scarce as well as the interspecific ones in the three main non web-spiders species listed from the apple trees : *Anyphaena accentuata*, *Philodromus cespitum* and *Diaea dorsata*. Nevertheless, in these experiments if the weight ratio of a pair of spiders is high, above 4, there are frequent cases of predation and then it occurs rapidly. The study conditions were deliberately made extreme. There was no shelter nor any possibility of escape for the Araneids. The volume of the enclosures was very small and the spiders were hungry. Therefore, the cannibalism that occurred in these conditions could be considered as a maximum rate for these three species. In natural circumstances, these conditions do not exist and it is likely that the smaller spiders are able to find shelter in vegetation to escape the predation of a bigger conspecific.

The videographic analysis confirms that the scarce cases of predation between these spiders are not the consequences of any lack of movement in the enclosures, but that there are, indeed, interactions limiting this predation. In spite of very numerous encounters (up to 379 during a circadian period) there is no predation. Furthermore, there are some avoidances phenomena in *Anyphaena accentuata* that minimize the risks of intraspecific predation. It is shown that during the experiments an increase number of theoretic contacts are replaced by avoidances (figure 6). These results are supported by NOSSEK & ROVNER (1984), they showed in Lycosidae species that food deprivation did not increase conspecific cannibalism and even that hunger lowers their fighting potential and thereby increases their avoidance tendency. The study of the mechanisms of recognition and the description of the agonistic behaviour still remains to be carried out. Nevertheless the observation of the behaviour of *A. accentuata* seems to point to strong similarities with the behaviour of the lycosid spiders studied by NOSSEK & ROVNER (1984). Moreover, this study also pointed out that *A. accentuata* is a nocturnal wandering spider. The avoidance phenomena suggest, in this species supposedly with poor vision, a distance recognition probably due to mechanoreceptors. There is a peak of activity at the beginning of the night probably connected with a hunting period as it was shown in a close-related family species *Clubiona corticalis* (MARC, 1990). SCHMITT & al. (1990) show a similar peak in three species of *Cupiennius*. The locomotory activity and the photoperiod synchronize and this is confirmed by a previous study on this species (unpub. data).

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Comparaison de 2 méthodes d'étude sur l'écologie et la structure des peuplements d'araignées des lisières

par

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Summary: In order to study the spiders communities of the edge of woods, are presented two sampling methods: visual, time-limited observation "in situ" and extraction of animals from a definite volume of forest. The method of extraction is limited to the description of the spider communities, and the method of observation "in situ", although permitting to study the evolution of the spiders species assembly in time, lacks precision.

1. INTRODUCTION

Malgré son souci de distinguer les milieux par des systèmes de classification élaborés, l'homme s'est toujours trouvé emprunté pour définir les caractéristiques des zones de transition brusques telles que les lisières de forêt. L'exemple le plus frappant est celui de la phytosociologie "classique" qui ne peut se défaire de la notion d'homogénéité. D'autres approches, comme c'est le cas de l'approche synusiale (GILLET 1985), sont prometteuses mais se situent encore dans la phase expérimentale précédant la standardisation. La description de l'évolution progressive dans l'espace de la structure du biotope est l'une des difficultés rencontrées.

L'idée que les araignées sont de bons indicateurs écologiques des types d'habitats est largement répandue (BUCHAR 1983; CLAUSEN 1986; RUZICKA 1986; BLANDIN 1986; KLIMES 1987; MAELFAIT & BAERT 1988a, 1988b; MULHAUSER B. 1990; MULHAUSER G. & MULHAUSER B. in prép.). Cependant, l'utilisation que l'on peut en faire se heurte également au problème de la standardisation des méthodes. Pour déterminer la composition des populations d'araignées, cer-

tains auteurs utilisent le filet-fauchoir (DABROWSKA-PROT & LUCZAK 1968; LUCZAK 1990), d'autres le piège d'interception au sol du type Barber (ALBERT 1976; HEUBLEIN 1982, 1983; MULHAUSER 1989), le photoélecteur (ALBERT 1976) ou bien une panachée de plusieurs méthodes (TURNBULL 1960; ALBERT 1982).

L'observation directe sur le terrain (species counting in situ, SOUTHWOOD 1978) n'est pas délaissée mais, chose curieuse, alors qu'elle semble couramment utilisée en arachnologie sur le continent américain (ENDERS 1974; LUBIN 1978; BROWN 1981; GREENSTONE 1984), elle est peu connue en Europe. Cette dernière méthode est présentée dans ce travail et nous l'appellerons, par commodité, méthode d'observation "in situ".

La seconde méthode présentée consiste à extraire les animaux par strate d'un volume défini de lisière (quantitative sampling). Couramment utilisée pour les recensements d'invertébrés, elle nous paraît peu fréquente en arachnologie. Nous l'avons appelée méthode d'échantillonnage "par extraction".

La présente communication livre certaines réflexions sur ces 2 méthodes basées sur des résultats qualitatifs (présence-absence des espèces). Pour conclure, nous nous permettons de donner notre avis sur l'applicabilité des 2 méthodes pour des travaux de description des peuplements d'araignées des lisières et leur évolution.

2. PRESENTATION DES METHODES

2.1 Méthode d'observation "in situ"

La méthode d'observation "in situ" se déroule de la manière suivante :

- Localisation de la parcelle d'étude sur le terrain de "manière aveugle" (la personne lance un objet au loin dans la lisière; son point de chute déterminera la position de la parcelle).
- Délimitation de la zone (4 m² dans notre cas) à l'aide de double-mètres posés délicatement sur le sol.
- Détermination de la distance séparant la parcelle d'étude du premier arbre de la forêt.
- Observation des araignées en restant sur le pourtour de la parcelle.
- Détermination, sans les capturer, des araignées et indication de leur position (horizontale et verticale), de leur stade de développement, du support végétal utilisé et de l'exposition.
- Pénétration dans la parcelle et répétition du travail.

Plusieurs données (recueillies avant ou après le relevé) complètent ce recensement: des données générales sur le milieu (relevé de végétation, recouvrement, température, nappe d'eau) et des données météorologiques.

Le relevé total correspond donc à l'image tridimensionnelle des populations d'araignées à un endroit donné de la lisière et à un moment donné. La répétition des relevés per-

met d'obtenir une image synthétique des populations d'araignées sur toute l'étendue d'un transect de lisière.

2.2 Méthode d'échantillonnage "par extraction"

La méthode d'échantillonnage "par extraction" se déroule de la manière suivante :

- 4 parcelles contiguës ($4 \times 1 \text{ m}^2 = P1, P2, P3, P4$), situées perpendiculairement à la lisière (transect de lisière), sont définies préalablement (environ 2 jours avant le relevé) à l'aide de piquets. Sur ces piquets, des marques de couleur indiquent la hauteur des diverses strates choisies (A,B,C,D,E).
- Mise en place d'un cadre de ramassage de 50 cm de hauteur, autour de la parcelle.
- Observation "à l'oeil" des araignées et récolte à l'aide d'un aspirateur à bouche.
- Récolte de la végétation en respectant les strates. Deux personnes sont nécessaires pour effectuer ce travail: l'une d'elles prélève délicatement la végétation (branches, herbes) à l'aide d'un sécateur tandis que l'autre récupère la coupe dans un carré de tissu maintenu rigide par 2 bâtons. Le tout est ensuite rapidement déposé dans un sac fermé.
- Récolte des araignées du sol, maintenues dans le périmètre grâce au cadre de ramassage, à l'aide d'un aspirateur à bouche.
- Tri des sacs de végétation contenant les invertébrés en laboratoire (pas d'utilisation des extracteurs Berlèse)
- Conservation des invertébrés, dans l'alcool, jusqu'à la détermination.
- Etablissement d'une liste présence-absence des espèces d'araignées.

Plusieurs données complètent ce recensement: relevé de végétation, recouvrement, index foliaire, ensoleillement.

Après détermination, le relevé correspond à l'image tridimensionnelle des populations d'araignées d'un transect de lisière. Le résultat théorique est donc le même que celui obtenu par la première méthode.

3. RESULTATS

La comparaison entre les 2 méthodes d'étude se base sur un nombre de relevés définissant une surface égale (12 m^2), durant la même période (mois d'août) et dans des types de lisière supposés identiques (dans ce cas, des lisières de feuillus n'ayant jamais subi d'entretien). Il faut cependant signaler que les relevés "in situ" se sont faits dans 3 sites différents alors que ceux de la méthode "par extraction" ont été effectués sur une même lisière.

Afin de rendre indépendante du système de classification synphytosociologique la définition des habitats des différentes espèces d'araignées, nous n'avons pas cherché à caractériser les lisières étudiées par des termes qui lui sont empruntés. Comme le sou-

lignent ELTON et MILLER (1954), DUFFEY (1966) et GREENSTONE (1984), la connaissance des composantes structurales d'un biotope devient essentielle lorsqu'il s'agit de travailler sur les types d'habitats des populations d'animaux; rattacher un nom de groupement végétal devient secondaire.

Le tableau 1 représente les images, relatives aux 2 méthodes, de la structure horizontale et verticale des peuplement d'araignées selon un profil type de lisière (fig.1) divisée en étages (A,B,C,D,E) et en parcelles (P1,P2,P3,P4).

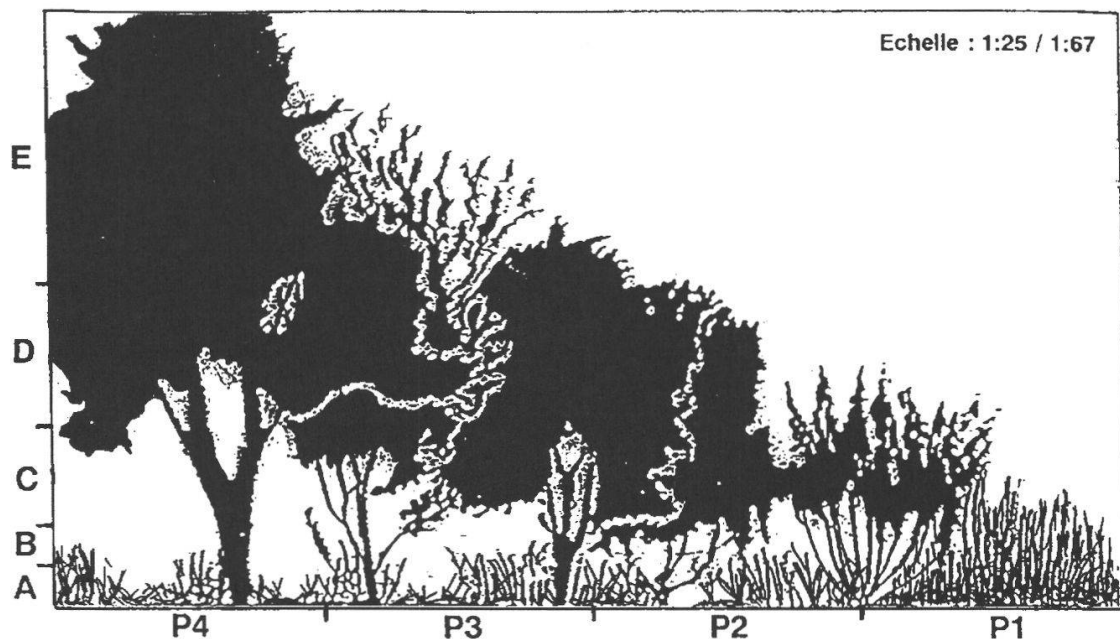


Fig. 1 -profil type de lisière

Légendes: A: 0-40 cm; B: 40-80 cm; C:80-160 cm; D:160-320 cm; E: 320-600 cm.

P1: -100-0 cm; P2: 0-100 cm; P3: 100-200 cm; P4: 200-300 cm.

0 cm = premier arbre de la forêt

4. INTERPRETATION DES RESULTATS

Nous avons recensé 44 espèces par l'extraction d'un volume défini de la lisière, alors que seulement 23 espèces ont été observées "in situ" pour un nombre comparable de relevés.

Cependant, si nous doublons les recensements "in situ", 13 espèces nouvelles complètent alors la composition en espèces (espèces marquées X dans le tableau 1).

	Structure horizontale		Structure verticale	
	"in situ"	"par extraction"	"in situ"	"par extraction"
<i>Tetragnatha extensa</i> (Linne)	P1	-	A,B,C	-
<i>Tetragnatha montana</i> (Simon)	P1,P2,P3,P4	P2,P3,P4	C,D,E	A,B,C,D,E im.
<i>Tetragnatha nigrita</i> (Lendl)	P3,P4	-	C,D,E	-
<i>Metellina segmentata</i> (Clerck)	X	P3,P4	-	A,B
<i>Araneus marmoreus</i> (Clerck)	P1,P2,P3,P4	P2,P3,P4	B,C	A,B,C
<i>Araniella cucurbitina</i> im. (Clerck)	P3	P4	D	D
<i>Larinioides cornutus</i> (Clerck)	P1	-	C,D	-
<i>Larinioides patagiatus</i> (Clerck)	P3	-	D,E	-
<i>Mangora acalypha</i> im. (Walck.)	P2,P3	P4	A,B,C,D	A
<i>Singa hamata</i> (Clerck)	P1,P2	P1,P4	B,C,D	B,C
<i>Zilla diodia</i> (Walck.)	P1,P2	-	C,D	-
<i>Ero furcata</i> (Villers)	-	P1	-	A
<i>Gongyliellum murcidum</i> ad. (Simon)	-	P3	-	A
<i>Pocadicnemis juncea</i> ad. (Locket & Mill)	-	P1	-	A
<i>Floronia bucculenta</i> (Clerck)	-	P1,P2,P3,P4	-	A,B
<i>Kaestneria pullata</i> ad. (O.P.-Cambr.)	-	P2	-	A
<i>Leptyphantes menegi</i> ad. (Kulczynski)	-	P1,P2,P3,P4	-	A
<i>Leptyphantes pallidus</i> ad. (O.P.-Cambr.)	-	P1	-	A
<i>Linyphia triangularis</i> (Clerck)	P1,P2,P3,P4	P2,P3,P4	A,B,C	A,B,C ad.
<i>Neriene clathrata</i> im. (Sund.)	-	P1,P2,P3,P4	-	A
<i>Enoplognatha ovata</i> (Clerck)	X	P3,P4	-	A,D
<i>Robertus lividus</i> ad. (Blackw.)	-	P2	-	A
<i>Theridion instabile</i> ad. (O.P.-Cambr.)	-	P4	-	A
<i>Theridion pictum</i> ad. (Walck.)	X	P2	-	B,C
<i>Theridion varians</i> ad. (Hahn)	-	P3,P4	-	C
<i>Hygrolycosa rubrofasciata</i> (Ohlert)	X	P1,P3	-	A
<i>Pardosa lugubris</i> (Walck.)	P1,P2,P3,P4	-	A	-
<i>Pardosa prativaga</i> (L. Koch)	P1	-	A	-
<i>Trochosa terricola</i> ad. (Thorell)	-	P2	-	A
<i>Dolodomes fimbriatus</i> im. (Clerck)	P1,P2	P3	B,C	C
<i>Pisaura mirabilis</i> ad. (Clerck)	P1	-	A,B	-
<i>Pisaura mirabilis</i> im. (Clerck)	X	P1	-	D
<i>Agelena labyrinthica</i> (Clerck)	P1,P2,P3,P4	-	A	-
<i>Hahnina pusilla</i> ad. (C.L. Koch)	-	P2,P3,P4	-	A
<i>Anypaena accentuata</i> im. (Walck.)	X	P3	-	D
<i>Phrurolithus festinus</i> ad. (C.L. Koch)	-	P2	-	A
<i>Clubiona lutescens</i> ad. (Westring)	-	P2	-	B
<i>Clubiona phragmitis</i> ad. (C.L. Koch)	X	P1,P2,P3,P4	-	A
<i>Zora spinimana</i> (Sund.)	-	P1,P2,P3,P4	-	A
<i>Micrommata virescens</i> (Clerck)	P1	-	A	-
<i>Philodromus cespitum</i> (Walck.)	P1	-	B	-
<i>Tibellus prob. maritimus</i> im. (Menge)	X	P2	-	A
<i>Tibellus prob. oblongus</i> im. (Walck.)	P1	P1,P2,P3	A	A
<i>Misumena vatia</i> ad. (Clerck)	P1	-	A,B	-
<i>Misumena vatia</i> im. (Clerck)	P1,P2	P1,P2,P3,P4	B,C	C,D,E
<i>Oxyptila trux</i> ad. (Blackw.)	-	P1	-	A
<i>Tmarus piger</i> (Walck.)	X	P1,P2,P3,P4	-	A,B,C,D
<i>Ballus chalybeius</i> (Walck.)	-	P1,P3,P4	-	A,D,E
<i>Euophrys frontalis</i> (Walck.)	P1	P1,P2,P3,P4	A	A
<i>Evarcha arcuata</i> (Clerck)	P1,P2	P1,P2,P3	B,C	A,B ad.
<i>Heliophanus auratus</i> ad. (C.L. Koch)	-	P1,P2,P3	-	A,D,E
<i>Marpissa muscosa</i> ad. (Clerck)	X	P2	-	A
<i>Marpissa radiata</i> (Grube)	X	P1,P2,P3	-	A,B,C
<i>Myrmarachne formicaria</i> (Degeer)	X	P1,P2,P3	-	A,C,D,E
<i>Neon reticulatus</i> ad. (Blackw.)	-	P2	-	A
<i>Saliculus prob. zebraneus</i> (C.L. Koch)	P2,P3	-	C,D	-
<i>Synageles venator</i> im. (Lucas)	X	P1	-	C

Tableau 1: Images qualitatives de la structure horizontale et verticale des peuplements d'araignées par les 2 méthodes d'étude discutées.

Nomenclature selon "le catalogue des araignées de Suisse", R. Maurer et A. Hänggi, 1990.

Légendes: A: 0-40 cm; B: 40-80 cm; C: 80-160 cm; D: 160-320 cm; E: 320-640 cm.

P1: -100-0 cm; P2: 0-100 cm; P3: 100-200 cm; P4: 200-300 cm.

X: espèces déterminables "in situ" si le nombre de relevés est dédoublé.

Ces résultats impliquent les conséquences suivantes:

- Des espèces indéterminables "in situ", en raison de leurs caractéristiques morphologiques peu marquées, manquent dans les relevés d'espèces. Ce sont *Ero furcata*, *Gongylidiellum murcidum*, *Pocadicnemis juncea*, *Kaestneria pullata*, *Robertus lividus* ou, en ne considérant que le genre, *Leptyphantes* sp., *Theridion* sp., *Hahnia* sp., *Clubiona* sp., *Oxyptila* sp., *Heliophanus* sp.. Ceux-ci restent donc partiels.
- Pour le recensement des espèces restantes, le nombre de relevés doit être plus important (couvrant environ le double de la surface) "in situ" que "par extraction" d'un volume de lisière.

Quelques espèces n'ont pas été récoltées par la méthode "par extraction". Il s'agit d'une part d'araignées errantes (*Pardosa lugubris*, *Pardosa prativaga*, *Pisaura mirabilis* adulte, *Micrommata virescens*) qui s'enfuient à l'approche de la personne effectuant les échantillonnages, et d'autre part d'araignées absentes lors du relevé. C'est sans doute le cas pour les espèces vivant dans la strate herbacée des milieux non boisés (P1) comme *Tetragnatha extensa*, *Larinioides cornutus*, *Philodromus cespitum*, *Misumena vatia* adulte: ces araignées évitent les bordures de forêt où la végétation herbacée est trop dense. La lisière choisie pour le test de la méthode d'extraction contenait en l'occurrence une zone à marisque (*Cladium mariscus*) dense.

4.1 Structure horizontale

Compte tenu des remarques faites précédemment, si nous considérons les espèces communes aux relevés des 2 méthodes, l'image de la structure horizontale est assez semblable. Deux biais montrent cependant les difficultés d'application de chacune des méthodes:

- Lors de l'observation "in situ", il est difficile de pénétrer dans le manteau forestier. Si nous ne prêtons pas une attention particulière aux relevés de cette zone, la densité d'observation reste faible. Quelques espèces sont "oubliées". Ces espèces peuvent varier d'un recensement à l'autre.
- Lorsqu'il s'agit d'échantillonner les araignées par coupe des branches et des herbes de la lisière, le dérangement est important dans les zones adjacentes à la coupe. Cela a pour conséquence une fuite des araignées errantes (et sans doute quelques tisseuses).

4.2 Structure verticale

L'image de la structure verticale, obtenue par les 2 méthodes, est assez semblable si on ne considère que les espèces communes aux 2 types de relevés.

Deux constatations intéressantes sont à faire:

- La majorité des espèces non recensées par la méthode "in situ" (20 espèces) se situent dans la strate A, c'est-à-dire entre 0 et 40 cm de hauteur. Le dégagement total du sol (coupe de la végétation avec cadre de ramassage) est donc nécessaire pour obtenir une image réelle des populations d'araignées dans cette strate. Ce sont principalement des espèces de petite taille dont la détermination sur le terrain s'avère impossible (*Erigoninae* par exemple).

- Dans les strates élevées, la proportion d'immatures augmentent considérablement. Les immatures de 7 espèces sur 10 sont localisées dans les strates arbustives et arborescentes alors que leurs adultes vivent, pour la plupart, dans la strate herbacée (*Misumena vatia*, *Dolodomes fimbriatus*, *Pisaura mirabilis*, *Myrmarachne formicaria*). Cette remarque souligne l'importance d'un travail de recherche sur la différenciation des habitats entre adultes et immatures d'une même espèce et confirme que l'emploi d'un piège d'activité, tel que le piège Barber, serait mal adapté à une étude complète des populations d'araignées.

5. AVANTAGES ET INCONVENIENTS DES 2 METHODES

Dans le but de bien cerner les différences qui existent entre ces deux méthodes, nous avons regroupé les avantages et les inconvénients dans le tableau ci-dessous.

5.1 Méthode d'observation "in situ"

Avantages

- La parcelle d'étude ne subit que peu de modifications; elle est, par conséquent, réutilisable.
- Les individus observés ne sont pas tués.
- Le comportement, l'utilisation de l'espace, la phénologie des espèces peuvent être étudiés.
- Le relevé demande peu de temps.

Inconvénients

- Beaucoup d'espèces d'araignées ne sont pas recensées; soit qu'elles soient indéterminables (beaucoup d'immatures et petites espèces vivant dans la litière, etc. La composition en espèces n'est, par conséquent, pas complète.
- Les relevés ne sont pas quantitatifs.

5.2 Méthode d'échantillonnage "par extraction"

Avantages

- Une grande partie des araignées d'un volume défini de lisière sont récoltées.
- Les relevés permettent de calculer la densité, la diversité, la biomasse des peuplements d'araignées (ces aspects n'ont pas été abordés dans ce travail).

Inconvénients

- Destruction totale de la parcelle d'étude.
- Mort des individus récoltés.
- Les relevés demandent beaucoup de temps (récolte sur le terrain, tri en laboratoire, etc.).
- Fuite possible d'un certain nombre d'araignées errantes.

6. CONCLUSION

Chacune des 2 méthodes présente des inconvénients; cependant, la présentation de leurs avantages incite à ne pas les condamner à priori.

Ces 2 méthodes s'appliquent à des buts différents:

- La méthode d'échantillonnage "par extraction" permet d'obtenir une image **complète** mais **ponctuelle** du peuplement d'araignées. Elle se limitera généralement à cet aspect descriptif statique (destruction du biotope) mais pourrait être préférée dans ce but à une panachée de méthodes différentes qui fournit des résultats, certes complets (ALBERT 1982) mais qui est longue et fastidieuse.
- La méthode d'observation "in situ" donne une image **incomplète** mais **dynamique** si les relevés sont répétés dans le temps. Elle convient particulièrement aux études désirant suivre l'évolution des peuplements d'araignées d'un milieu tout en sachant qu'elle se limite à recenser une partie des espèces et non pas la totalité. Les espèces recensées, précieuses indicatrices des changements intervenus dans le biotope, permettent de découvrir les déviations ou distorsions évolutives d'un état théorique dues à des facteurs anthropiques.

Pour effectuer une étude de longue haleine sur les peuplements d'araignées des lisières, il serait possible, à notre avis, de :

- Débuter par une description complète du milieu, réalisable par la méthode "par extraction". Cette étude servirait de référence pour les travaux futurs dans ce même milieu.
- De poursuivre par la méthode "in situ".

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Zoogeographical features of the European Fauna of Salticidae (Araneae), an overview of 30 years of research

par
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"... Sto mil od brzegu i sto mil za brzegiem ...
... Nowi gdzieś ludzie w sto lat będą po mnie
patrzący marli ..."
[... Hundred miles to coast and hundred off coast
..... New men somewhere hundred years later
will die looking on ...]
(Juliusz Słowacki, "Hymn", 1836-1837)

After two centuries of research, half way in study of taxonomy and zoogeography of *Salticidae*, how much have we progressed and what progress may be expected in the future?

We started endowed by our predecessors with a wealth of preliminary data and their numerous ... mistakes. How grateful we should be for these mistakes! Would we have an incentive for research if our predecessors were infallible? Just let us recollect our discussions running so often along the line: "species X differs from Y by character Z which was overlooked (or misinterpreted) by the ancestor A, ONLY I managed to put it straight". I suppose that our own mistakes may provide similarly valuable inheritance to the coming generations of Arachnologists!

When I got interested in zoogeography, in the middle of 1950ties, the standard procedure was defining species as the "zoogeographical elements", usually within limits of the known part of Europe. So "*Philaeus chrysops*" was considered either "Pontic" or "Mediterranean element" whilst some other species were Boreo-Alpine, there were even "Gondwanian" elements. I started from taxonomic recognition and geographical pinpointing of species. A simple statistics of distribution gave first ideas on grouping Salticidae over the continents and on faunal units we are to deal with (Prószyński 1975).

We can smile now on crude approximations, sometime erroneous, with incomplete data and misinterpretation of systematic relations; on controversies overlooking difference in time of evolutionary radiation and dispersal abilities of taxa. As I understand now, there is more than one type of distribution, so contradictory conclusions drawn from different taxa do not necessarily must be wrong.

Filling up a jigsaw puzzle of relationships of species and plotting their distribution on maps shown regularities in distribution of closely related species, assumedly due to geography of speciation and subsequent dispersal (Prószyński 1975, 1976, 1978b, 1980a, 1981a, b). Even more important seem significant departures from these regularities in Europe and Siberia (PROSZYNSKI 1983a, 1986a&b, 1988) due to Ice Age destruction of environments and subsequent recolonization.

And so the Salticidae fauna of Europe is an incidental assemblage of species, of "geographical elements", and not a natural "society", developed on the spot, comparable to those on "luckier" continents. The term "geographical element" is conceptually different here from that used in 1950ties, it defines species by their area of origin, or at least by the area they came from. No longer can the same species be labelled as different element at opposite ends of its distributional range: Mediterranean in Poland, Central European in Italy. What matters is *where it came from*, and *when*. The time aspect is of utmost importance in these considerations. The age of recent Central European Salticidae fauna is only 10,000 years, no species surviving the Glacials on the spot, in difference to the cold adapted groups; but some of these Salticidae could recolonize during subsequent Interglacials. Very old elements like Gondwanian (meaning arrived from Gondwana and survived since) seem improbable in Palaearctics, due to stormy history of environmental changes.

The time factor in evolution of Salticidae remains uncertain. What is the age of particular taxa? What time is needed for speciation of a single species? For developing of a large genus? For decline of taxa previously dominant? Answer to these questions calls for comparison of faunae of areas of known geological age outside Europe, too young for that purpose. We need also better knowledge of taxonomy of Salticidae of other continents. A task for years. One may envy relict families, where each distributional spot may testify to the history of hundred of millions of years and to planetary processes like plate tectonics. However, numerous and differentiated family like Salticidae offers definitive methodical advantages: broad scale of variation, wealth of cases for comparison, opportunities for testing hypotheses.

Lets' recollect current views on our young European fauna of Salticidae. European fauna is not a proper unit in faunal distribution; the real one seem to be Eurosiberian fauna, stretching from Atlantic to Pacific, limited in the South by the Mediterranean coast, as well as grassland and desert environments of Asia. Southern neighbors of our fauna seems different than heretofore accepted. Mediterranean fauna, from which so many species migrated to Eurosiberia, seems to be limited to coastal lowlands of Western Mediterranean, and only rudimentarily represented in the Near East. The dry parts of Near East and Africa are in fact populated by different fauna called Eremial (POR 1975), intergrading to the South with Ethiopian (Afrotropical). Southern Palaearctic fauna of grasslands, semideserts and deserts, of different origin, intermixed

with Eurosiberian one during postglacial Northern dispersal; contains also old Ice Age Eurosiberian relicts in the Middle and Central Asian Mountains, which produced local endemic species. The Oriental fauna is sharply separated along Southern slopes of Himalayas and connected mountains, but intergrading in Eastern China, Korea and Primore, its influences visible as far as Baical Lake.

The Eurosiberian fauna itself strikes by the similarity of ranges of many widespread species: once entered the Eurosiberian Zone they spread quickly from one end to the another. The postglacial colonists come from around the Zone and so we trace species of presumably N-American origin from E-Siberia to the Atlantic; the Mediterranean and Eremial elements reaching E-Siberia; Southern Palaearctic species spreading beyond the Arctic Circle. Of special importance is recolonization from warmer enclaves by Glacials survivors of various origin, presumably repeated during subsequent Interglacials, and a few autochthonic preglacial genera (*Sitticus*, *Euophrys*) and preglacial colonist from Africa (*Heliophanus*). There are almost no cases of speciation in the Eurosiberian zone itself (an exception is *Sitticus rupicola*), although there are some pairs of sister species in the peripheral areas.

The general feature of Salticidae in Europe is the South-North decrease of a number of species (over 100 species in the Mediterranean coastal area, 75 in Czechoslovakia, 51 in Poland and 12 beyond Arctic Circle in Scandinavia -PROSZYNSKI 1976), due to halt in spreading by gradually cooler climate. Current research (VILLEPOUX 1986) corrected suspicion on Northern origin of a peat bogs (hochmoors) dweller *Heliophanus dampfi*, found in the Massif Central and possible even in Spain, it may be also a Southerner. Little is known on distribution of local species in W-Europe.

My recent work on a *Key to European Salticidae* gave me a sense of limitation of our knowledge. Some species are known from a single or a few specimens only. Biology and environmental requirements of majority is virtually unknown; matching of sexes uncertain. Paradoxically enough, a distinct progress in research during last decade is visible in Siberia, Middle Asia and China, with a good potential for further development. There appeared a generation of talented researchers, not yet spoiled by a freedom of exotic travels. We may expect quite a lot from them.

What broadening of our knowledge may we expect in the future, apart from improving recognition of species, description of new taxa, new details of distribution? Will our generalizations stand the test of time? That's unknown, but even if they provide only a challenge, they shall be at least useful.

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Allométrie de la reproduction chez les femelles d'*Araneus* (*Larinioides*) *suspica*

O. Pickard-Cambridge 1876, élevées en laboratoire

par

Raymond Ramousse

Summary: Some females *Larinioides suspica* complete a generation in less than half a year whereas others develop more slowly although they are reared from eggs of the same cocoon in the same controlled conditions. Females that mature early attain a smaller adult weight and size, have a shorter adult life, lay more often cocoons but lighter and containing less eggs than those which mature slowly. Tentative hypotheses to explain this polymorphism are discussed.

1. INTRODUCTION

Malgré les risques des extrapolations et les difficultés à transposer au milieu naturel les résultats d'élevage, c'est, pour l'instant encore, la meilleure façon de connaître l'histoire individuelle des araignées, comme celle de nombreux invertébrés. Chez les Argiopidae, seulement deux espèces de la zone tempérée ont été étudiées dans cette perspective (*Zygiella x-notata*: LE GUELTE 1966; LIVECCHI 1978 - *Araneus diadematus*: BONNET 1930; RAMOUSSE 1973), sept espèces de la zone tropicale (*Argiope argentata* et *A. aemula*: ROBINSON & ROBINSON 1978; *A. trifasciata* et *A. flavipalpis*: EDMUNDS 1980; *Gasteracantha versicolor*: EMERIT 1969; *Nephila madagascariensis*: BONNET 1929; CANARD 1973; *N. maculata*: ROBINSON & ROBINSON 1976; *N. pilipes pilipes*: MALAISSE & BENOIT 1980) et une espèce australienne (*Nephila edulis*: AUSTIN & ANDERSON 1978). Les élevages permettent de quantifier de nombreux paramètres de la biologie temporelle des animaux et de mettre en évidence un éventuel polymorphisme de taille en relation avec le succès reproducteur des femelles. Cette variabilité est sous la dépendance de variations environnementales (régime ali-

mentaire, densité de proies, densité de la population...), mais elle peut s'exprimer aussi chez des araignées de même origine élevées dans des conditions identiques. A la suite d'une étude de la biologie reproductrice des mâles d'une espèce méditerranéenne, *Larinioides suspicax* (RAMOUSSE, 1990), élevés en captivité dans des conditions identiques, nous allons préciser divers aspects de la biologie reproductrice des femelles et leur possible signification adaptative.

2. MATERIEL ET METHODES

L*arinioides suspicax* est une espèce ripicole, de la façade méditerranéenne de l'Afrique. Ces araignées tissent des toiles orbiculaires sub-verticales avec une retraite soyeuse. Le dimorphisme sexuel est peu marqué (RAMOUSSE 1988). Les femelles sont itéropares et pondent leurs cocons à l'intérieur de leur retraite. Le développement embryonnaire est rapide (RAMOUSSE & WURDAK 1984).

L'élevage a été réalisé à partir d'oeufs pondus au laboratoire par des femelles récoltées à Touggourt (Algérie). 660 individus, prélevés aléatoirement par groupe de 20 dans chaque cocon, ont été placés, après l'essaimage au cours du stade J2, dans des boîtes individuelles d'abord de 10 x 10 x 17 cm, puis de 40 x 40 x 10 cm. Les conditions d'élevage sont uniformes: photophase de 12 heures (éclairage: 130 μ W/cm²; température 25 $\pm$ 2 °C.; humidité relative 50%) et scotophase de 12 heures (0,28 μ W/cm²; 15 $\pm$ 2 °C.; 75% H.R.). Chaque individu a la même opportunité de capture (drosophiles et mouches Calliphoridae), seul son succès de capture varie. La désignation des stades du développement post-embryonnaire suit la terminologie de CANARD (1987).

La réussite des accouplements est vérifiée par le développement ou non des cocons pondus par les femelles appariées. Chaque événement de la vie de chaque individu est enregistré: origine; dates de ponte, d'éclosion, des exuviations, de l'appariement, des pontes et du décès; poids frais de chaque individu, au 1/10e de mg, au moment de l'éclosion, après chaque exuviation, après chaque ponte et au moment de la mort de l'animal; taille de la première patte locomotrice (PL1) droite (coxa exclu) mesurée sur les exuvies; poids frais de chaque cocon; nombre d'oeufs par cocons; nombre de jeunes éclos.

3. DEVELOPPEMENT APRES LA SORTIE DU COCON

Les araignées écloses au sein du cocon y restent groupées une quinzaine de jours, puis le quittent et tissent à son voisinage une toile commune où elles séjournent quelques jours sans s'alimenter. Après une nouvelle mue, elles se dispersent, tissent des toiles individuelles et s'alimentent. Sur les 660 jeunes mis en élevage, 375 d'entre eux ont atteint la maturité sexuelle dont 161 femelles. En majorité (70%), les femelles muent huit fois (avec une gamme de trois possibilités). Le rangement des stades selon

leur durée est significatif quel que soit le nombre de stades (analyse de variance de Kruskal-Wallis). Il souligne l'importance du troisième stade (J2; mise en place des comportements liés à la vie individuelle) et du stade pénultième (différenciation sexuelle qui prépare la différenciation comportementale des adultes). La durée de développement des femelles augmente avec le nombre de mues (K-W: $p < 0,01$) et leur poids frais après la mue imaginale est d'autant plus élevé qu'elles ont effectué un plus grand nombre de mues, sans que les différences soient significatives (fig. 1). Le poids à maturité sexuelle pour un même nombre de mues présente en effet une variation importante suivant les cocons d'origine (7M: 110,5 mg; 32-183 / 8M: 149 mg; 84-269 / 9M: 200,5 mg; 153-328). La taille des araignées augmente avec le poids atteint à maturité sexuelle (Corrélation de Kendall; $n=143$; $p < 0,001$).

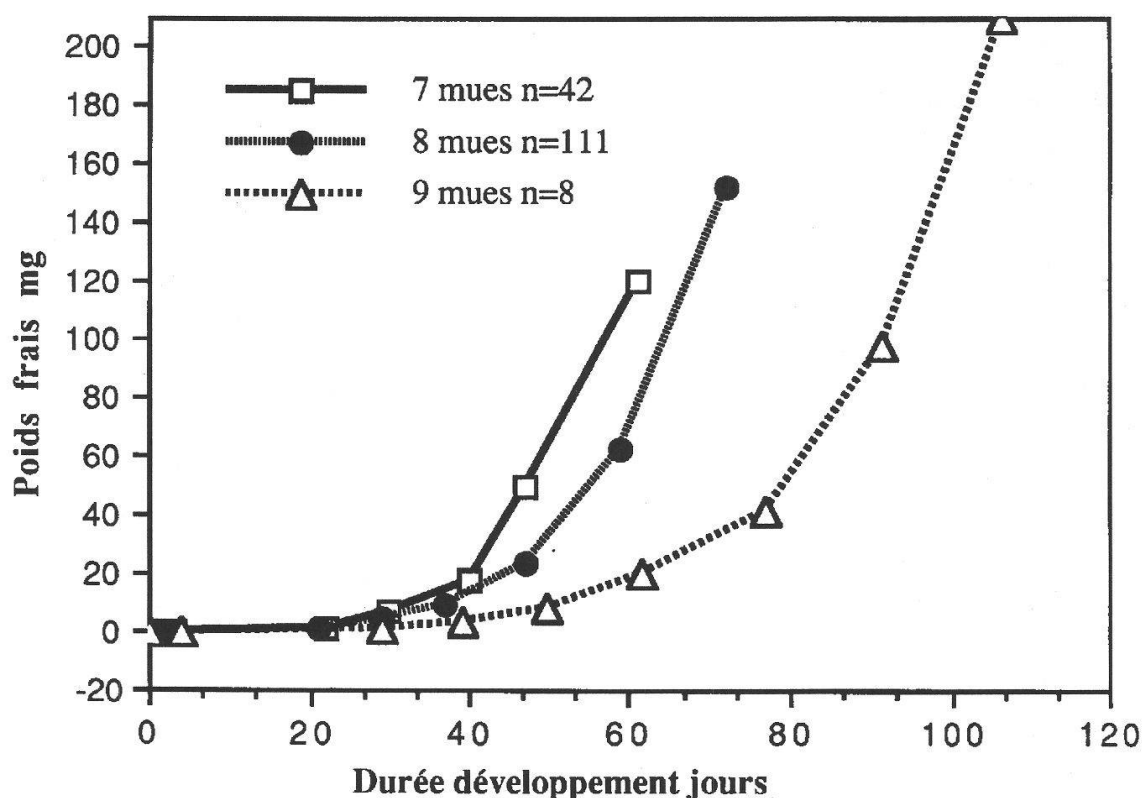


Fig. 1 - Evolution pondérale des femelles au cours du développement post-embryonnaire. L'intervalle entre deux points successifs correspond à la durée d'une intermue. Le point 0 indique l'éclosion.

L'état adulte est atteint en moyenne au bout de 61 (43-110), 72 (49-127) ou 107 (67-188) jours, selon que la mue imaginale est la mue 7, 8 ou 9. D'après l'ensemble des élevages, une femelle devient adulte en 70 jours (161 cas; valeurs extrêmes: 43-188 jours). Elle pèse alors 145 mg (47-269 mg) et la taille de sa première patte locomotrice est de 16,6 mm (10,1-21,0 mm). Les femelles d'élevage sont plus légères à maturité sexuelle que les femelles récoltées sub-adultes ($n=12$; médiane=213 mg; 133-383 mg) et ont des pattes plus courtes ($m=19,1$ mm; 17,7-23,1).

4. VIE ADULTE

La durée de vie augmente significativement avec l'allongement de la période de développement (K; $n=150$; $p=0,001$). Elle ne varie pas significativement que les femelles soient accouplées avec ($n=119$; $m=209$ jours; 22-484 j.) ou sans descendance ($n=13$; $m=205$ jours; 38-457 j.) ou qu'elles soient vierges ($n=24$; $m=364$ jours; 38-456 j.). Par contre, cette durée est de 5 mois en élevage ($n=161$; $m=212$ jours; 10-627 jours), alors que celle des femelles récoltées sub-adultes est de 9 mois ($n=12$; $m=275$ jours; 57-408 j.).

L'accouplement est possible et efficace jusqu'à plusieurs mois après l'arrivée à l'état adulte (5 mois pour les mâles et 8 mois pour les femelles). Dans la nature, les accouplements doivent avoir lieu précocement après la mue imaginale car une seule femelle sexuellement mature sur 24 récoltées s'est avérée vierge. La femelle n'est réceptive qu'une seule fois.

Les femelles superposent leurs cocons les uns aux autres à l'intérieur de leur retraite. Le premier cocon pondu éclôt le jour ou le lendemain de la ponte du deuxième cocon (environ 11 jours). Les jeunes quittent le premier cocon lorsque le troisième cocon est pondus. Ces jeunes araignées ne pénètrent pas dans les cocons non éclos.

Chaque femelle pond un nombre variable de cocons (NC; tab. I) et la fréquence de ponte décroît des femelles fécondées aux femelles vierges (fig. 2). Les femelles vierges, quand elles pondent, le font longtemps après la mue imaginale (IF; tab. I) et l'intervalle séparant deux pontes consécutives est plus long que celui des femelles appariées qu'elles aient une descendance fertile ou non (DI, tab. I). Les femelles appariées sans descendance fertile se trouvent dans une situation intermédiaire entre celle des femelles vierges et des femelles fécondées (tab. I). Après l'accouplement, les femelles pondent rapidement ($n=109$; $m=9$ jours; 3-15 j.). Par ailleurs, plus la fécondation est précoce après la mue imaginale, plus le nombre de cocons pondus est important (K: $p<0,05$). L'appariement avec un mâle et la copulation ont un effet sur le déclenchement de l'ovogenèse et sur le nombre de cocons pondus par une femelle. L'intervalle de temps séparant deux pontes fertiles successives augmente avec l'âge (K: $p<0,001$) ainsi qu'avec le poids atteint par les femelles à l'âge adulte (K: $p<0,01$). Les femelles fécondées à développement rapide pondent plus souvent que les femelles à développement lent (K: $p=0,04$). Cependant, comme ces dernières ont une durée de vie adulte supérieure à celle des premières, leur nombre total de cocons ne diffère pas (12 cocons).

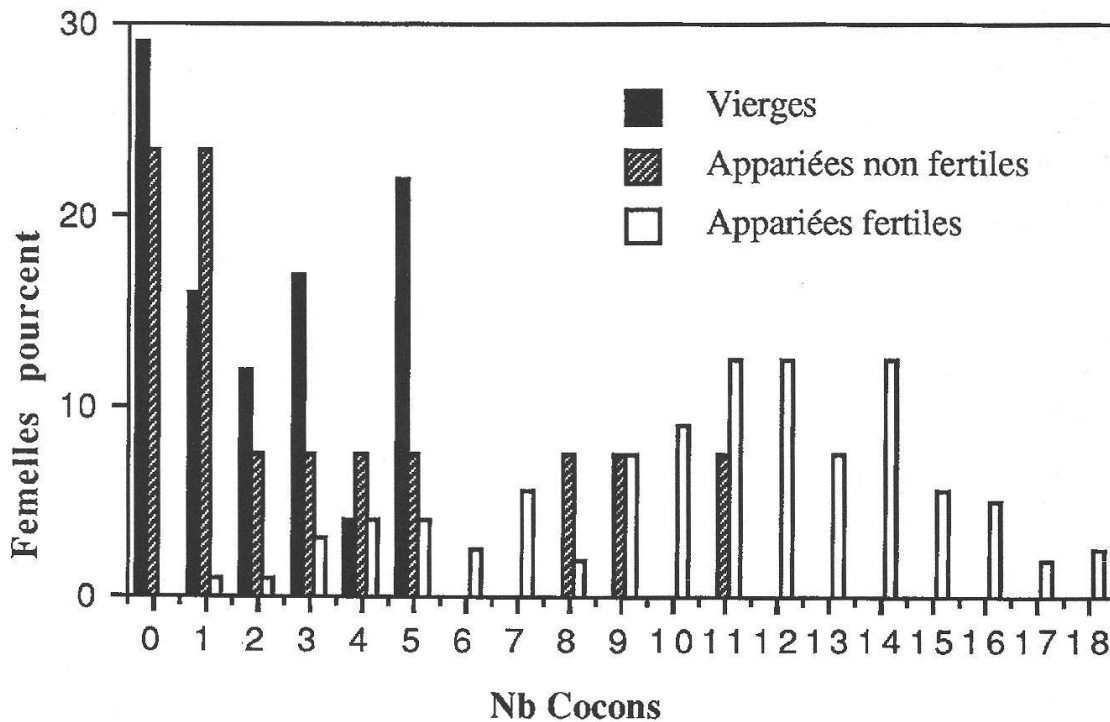


Fig. 2 - Distribution des femelles en fonction du nombre de cocons pondus.

	Femelles vierges		Femelles appariées sans descendance		Femelles fécondées	
	m	ve	m	ve	m	ve
NC	2	0-5	3,5	0-14	11	1-19
PC	115	50-199	118	99-158	108	6-204
PT	263	81-93	504	150-1411	1176	38-2321
PF	351	272-487	260	161-332	211	121-539
Pm	354	186-643	296	145-382	288	55-1108
IF	104	52-149	70	14-163	31	6-148
DI	31	10-71	15	8-56	11	7-44

Tab. I - Paramètres de la production des femelles.

NC: Nombre médian de cocons; PC: Poids médian d'un cocon (mg); PT: Poids total médian des cocons pondus par une femelle; PF: Poids médian des femelles après la ponte d'un cocon; Pm: Poids médian des femelles à leur mort; IF: Intervalle (jours) séparant la mue imaginale de la première ponte (celui-ci dépend du moment de fécondation pour les femelles fécondées); DI: Durée médiane (jours) entre deux pontes consécutives. m: Médiane; ve: valeurs extrêmes.

Le poids médian des cocons pondus par une femelle est en corrélation positive avec son poids (K: $p=0,002$) et avec sa taille (K: $p<0,001$) à maturité sexuelle. Mais, les femelles fécondées pondent des cocons plus légers que les femelles vierges (PC; tab. I; Mann-Whitney: $p=0,008$). Il n'y a pas de relation stricte entre le poids d'un cocon et son ordre

de ponte. Cependant, chez les femelles fécondées, le premier (14%) ou un des trois premiers cocons pondus (34%) peut être plus lourd que la femelle pesée immédiatement après la ponte. Les derniers cocons sont, au contraire, toujours les plus légers. L'accroissement de poids de la femelle entre deux cocons est de l'ordre de 120%. Ce gain est investi en grande partie dans la ponte, mais une partie est conservée par la femelle. Cet investissement dans les oeufs est plus important chez les femelles fécondées que chez les autres (PF; tab. I). Le poids total d'oeufs pondus par une femelle fécondée est en moyenne de 1176 mg (PT; tab.I). Il croît significativement avec la durée de vie adulte des femelles (K: $p=0,0018$).

Le nombre d'oeufs dans un cocon est extrêmement variable d'une femelle à l'autre et d'un cocon à l'autre pour une même femelle ($n=282$; $m=158$ oeufs par cocon; 33-536 oeufs). Mais pour une femelle donnée, ce nombre est maximum pour les premiers cocons et minimum pour les derniers. Le nombre d'oeufs par ponte croît avec le poids frais des cocons (K: $p<0,001$). Ces relations et celles concernant le nombre et le poids des cocons indiquent que la fécondité des femelles à développement lent est supérieur à celle des femelles à développement rapide. Tous les oeufs d'un cocon d'une femelle fertile n'éclosent pas (en moyenne 23% des oeufs d'un cocon). Si certains de ces oeufs peuvent ne pas avoir été fécondés, la majorité d'entre eux présente cependant un début de développement embryonnaire. Le poids des jeunes à l'éclosion varie d'un cocon à l'autre (il est compris entre 0,51 et 0,97 mg avec une valeur médiane de 0,60 mg pour 384 cocons), que les cocons soient pondus par la même femelle ou non. Ce poids augmente significativement avec le poids frais du cocon (K: $n=384$; $p<0,001$). De plus, au sein d'un même cocon, il semble qu'il puisse y avoir de légères différences de poids entre les individus bien qu'elles soient difficiles à mettre en évidence du fait de la précision de la mesure.

5. DISCUSSION

De la même façon que chez les mâles de *Larinioides suspicax*, nous pouvons distinguer des individus à développement plus ou moins rapide. Les femelles se développant rapidement ont une taille et un poids à maturité sexuelle inférieur à ceux des femelles à développement lent. Cette différenciation entre les individus d'un cocon élevés dans des conditions identiques a été observé chez les Argiopidae comme dans d'autres familles (DRESCO-DEROUET, 1960; VACHON, 1965; LE GUELTE, 1966; WITHCOMB et al., 1966; EMERIT, 1968; LEVY, 1970; CÉLERIER, 1971; REED & WITT, 1972; RAMOUSSE, 1973; BONARIC, 1980). Dans de telles conditions, l'intervention de facteurs internes d'origine métabolique, hormonale ou génétique a été postulée (BONARIC 1980). Les individus à croissance rapide pourraient avoir un métabolisme plus élevé et/ou tisser des pièges plus performants et/ou capturer plus de proies, comme cela a été mis en évidence chez *Araneus diadematus* (RAMOUSSE 1973). Une aptitude plus ou moins grande à capturer des proies a été postulée pour expliquer

l'importance de la variabilité du développement de *Misumena vatia* (Fritz et al. 1985). Les femelles *Larinioides suspicax* à croissance rapide pondent à des intervalles plus courts, mais cet avantage est contrebalancé par une durée de vie adulte réduite et une fécondité moindre (des oeufs moins nombreux et plus légers). Le maintien d'une variabilité intraspécifique du développement permettrait à l'espèce de surmonter les variations environnementales et d'avoir une occupation optimale du milieu. Les femelles, grâce à leurs nombreux cocons, répartissent les risques tout au long de la période de ponte. Mais les femelles à croissance rapide profiteraient de conditions environnementales favorables, alors que les autres, en particulier grâce à leur besoins réduits et leur production d'oeufs plus riches en réserves vitellines, assureraient la survie aux périodes défavorables et limiteraient les risques encourus par leur progéniture (plus grand nombre de jeunes par cocon et jeunes plus gros). De plus, ce polymorphisme pourrait permettre à cette espèce de coloniser des habitats plus variés, les individus à besoins alimentaires élevés (croissance rapide) colonisant les milieux les plus riches, les autres s'installant dans les habitats marginaux. La coexistence de ces différents types de développement assurerait de meilleures chances de survie à l'espèce. Cette variabilité refléterait un polymorphisme génétique. Au contraire, une autre hypothèse, non exclusive des précédentes, peut expliquer l'existence d'une variabilité de développement parmi les individus d'un même cocon. Elle est fondée sur l'existence, pratiquement constante chez les araignées, d'oeufs non développés dans les cocons (LECAILLON 1913) et de deux processus comportementaux: l'oophagie au sein du cocon (HOLM 1940; SCHICK 1972; VALERIO 1974; RAMOUSSE 1986) et d'un cannibalisme précoce des juvéniles 2 sur les stades antérieurs (DOWNES 1988; RAMOUSSE 1988). Ces deux comportements permettent à certains individus, au sein d'un cocon, de se développer plus rapidement et d'aborder la période critique pour leur survie, que constitue l'essaimage et l'établissement individuel en un site favorable, en de meilleures conditions que les autres. D'autant qu'au cours de cette période, les besoins énergétiques des individus augmentent considérablement (ANDERSON 1978; SCHAEFER 1976) et qu'une augmentation du nombre de proies fournies aux premiers stades accélère leur développement (TURNBULL 1962). Ce travail, réalisé dans des conditions contrôlées, donc largement réductrices par rapport à celles réellement vécues par les araignées dans le milieu, montre l'intrication des paramètres intervenant dans la biologie reproductrice des araignées, particulièrement des araignées itéropares, et la difficulté à discuter leurs possibles significations adaptatives.

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Structure and ecology of invertebrates communities of stony debris in Czech Republic. Research project

par
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Summary: The stony ecosystems represent ideal objects of biogeographical and ecological research, owing to their special microclimate, owing to the role of the territory of Czech Republic in migrations of fauna during quaternary and owing to the minimal degree of man-made disturbance. 1922 stony localities, which total area is about 150 km², have been registered. The faunistic division of Czech Republic was used for the selection of the set of model localities.

1. INTRODUCTION

The middle-sized and small forms of relief play a very important role in ecosystems. As relatively small terrain barriers, they are responsible for minute deviations in microclimatic conditions, which represent a characteristic component of every ecotope. These microclimatic deviations cause the different composition of flora and fauna in the specific site (RUBIN et al. 1986). Among relief mesoforms are boulder accumulations arising as products of cryogenic weathering of some rocks. Boulder accumulations occur at favourable sites in mid- and high mountains around the world. Under favourable conditions, deep boulder layers with free interspaces emerge (block fields, debris fields, taluses, debris cones).

The Czech countries assume a biogeographically crucial position. During glacials they lay in a narrow corridor between the Northern and Alpine glaciation regions. During interglacial periods, the forming stony debris constituted forest-free islands in the forest-covered mid-European landscape.

The inaccessibility and economic unexploitability of stony debris make it a biotope that

has been affected (and investigated) by man to a very low degree. Owing to these facts, stony debris formations are ideal objects of biogeographical and ecological research (MOLENDI 1991).

2. HYPOTHESES

In the mid-European landscape, stony debris form island biotopes which isolation is analogous to the isolation of peat bogs. In some parts of stony debris, temperature is constantly near the freezing point all year round, whereas other parts never freeze. Some invertebrate species are specifically adapted to life in debris. Populations of some of them can exhibit morphological adaptations to life in superficial underground compartments. The internal layers of bare as well as afforested debris can host so far unidentified species of psychrophilous invertebrates, whereas the surface of bare debris can harbour so far unidentified species of thermophilous invertebrates. The species composition and structure of communities of invertebrates have developed in accordance to the kind and way of weathering of the rock, to exposure, and to the vegetation cover if any is present. The species location varies depending on depth, according to gradients of the basic ecological factors. A specific community of species is hosted by the "bottom" (the underground surface of the soil cover) of the debris.

3. AIMS OF THE WORK

To obtain taxonomic-morphological and ecological data on invertebrates inhabiting accessible compartments in the depth profile of stony debris. To obtain data on the stony debris microclimate. To describe the structure of invertebrate communities of these unexplored extreme biotopes. To find (i) how the structure of the communities is affected by the kind and way of decomposition of the rock, by the boulder size, by the exposure and by the regime of air streaming through the debris; (ii) how the structure of the communities varies in dependence on the degree of coverage by soil and on the degree of the succession of plant communities; (iii) how the island effect manifests itself in the stony debris; and (iv) what are the morphological (biological) adaptations of invertebrates of stony debris. To contribute in gaining insight of the extent of migration of Northern (or Alpine) faunistic elements in the periglacial zone and/or of Southern faunistic elements in the interglacial periods and in the Holocene. To establish whether in polluted regions, communities of invertebrates in stony debris are disturbed and if so, whether this effect can be employed in long-term monitoring of changes of the environment.

4. WORKING PLAN

Here we present our working plan for the coming years

- (1) Gaining a complex idea of the occurrence of stony biotopes in the Czech Republic.
- (2) Developing an efficient method of material collection and microclimate measurements inside the debris formations.
- (3) Selecting a representative set of localities.
- (4) Gaining and determining material of invertebrates.
- (5) Performing microclimate measurements in the debris.
- (6) Evaluating data of the stony debris, of the microclimate and of invertebrates communities inhabiting them, with allowance for their interrelations.

5. CONCRETE PROVISIONS AND PLAN DESIGN

- (1) A complete set of common topographic maps of the Czech Republic on the 1:10 000 scale was treated. This set involves five types of boulder accumulations, viz. stony surface, stony and gravel debris, block stream, moraine, and boulder group. In terms of the density of marks, the areas of the individual localities were converted to the fully stone area. 1922 localities with area larger than 1 ha and whose total area is about 150 km², have been so registered (fig. 1). Stony debris occur at any altitude from 150 to 1 600 m. 42 % localities involve isolated rocks or rock massifs. Forest-free parts are mapped for 8 % localities (according to field experience, this proportion is actually higher).

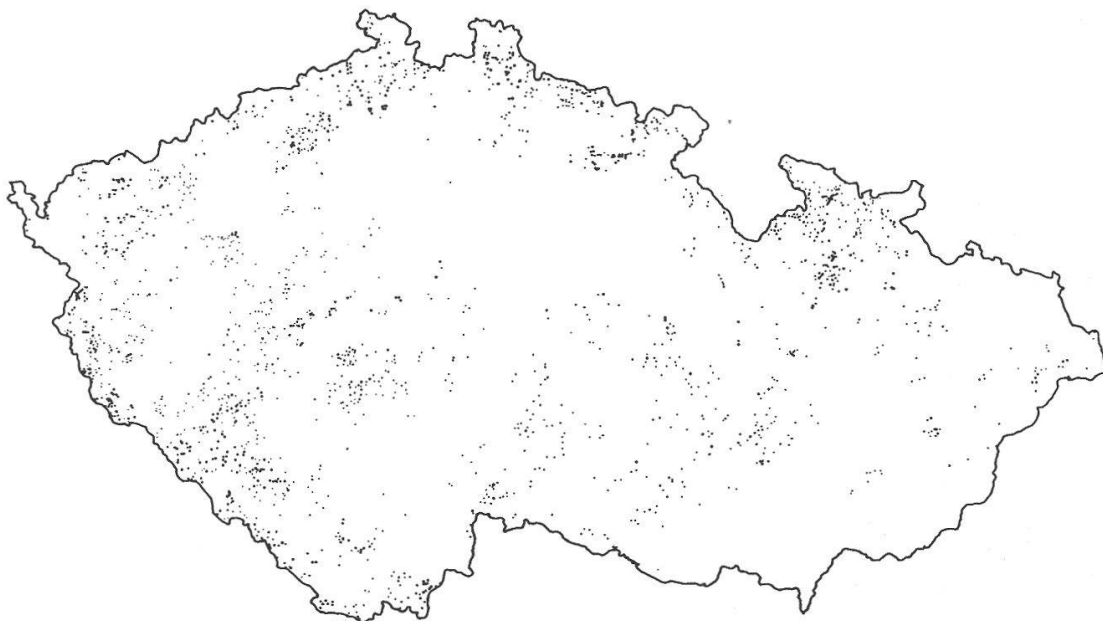


Fig. 1 - Boulder accumulations in Czech Republic. On the base of the maps 1:10 000. In area 4x enlarged.

Stony debris occurs in 97 small-area protected territories (fig. 2).

In the geobotanical map is mapped a unit of debris forest included in the Tilio-acerion KLIKA 1955 (fig. 3).



Fig. 2 - State Natural Reserves with protected debris ecosystems According to MARSAKOVA-NEMEJCOVA, MIHALIK et al. (1977), MARSAKOVA-NEMEJCOVA et al. (in press).



Fig. 3 - Debris forests - Tilio-acerion KLIKA 1955. According to MIKYSKA et al. (1972).

- (2) A modified type of pitfall traps for collecting material in stony debris was developed (RUZICKA 1988).
- (3) In each of faunistic district (ZELENY 1972), at least one locality was suggested for investigation by means of pitfall traps (fig. 4).
- (4) V. RUZICKA will determine the spiders, M. ZACHARDA the mites from the family Rhagidiidae (Eupodoidea), J. BOHAC the beetles. To the maximum extent possible, determination of other invertebrates material will be secured by cooperation.

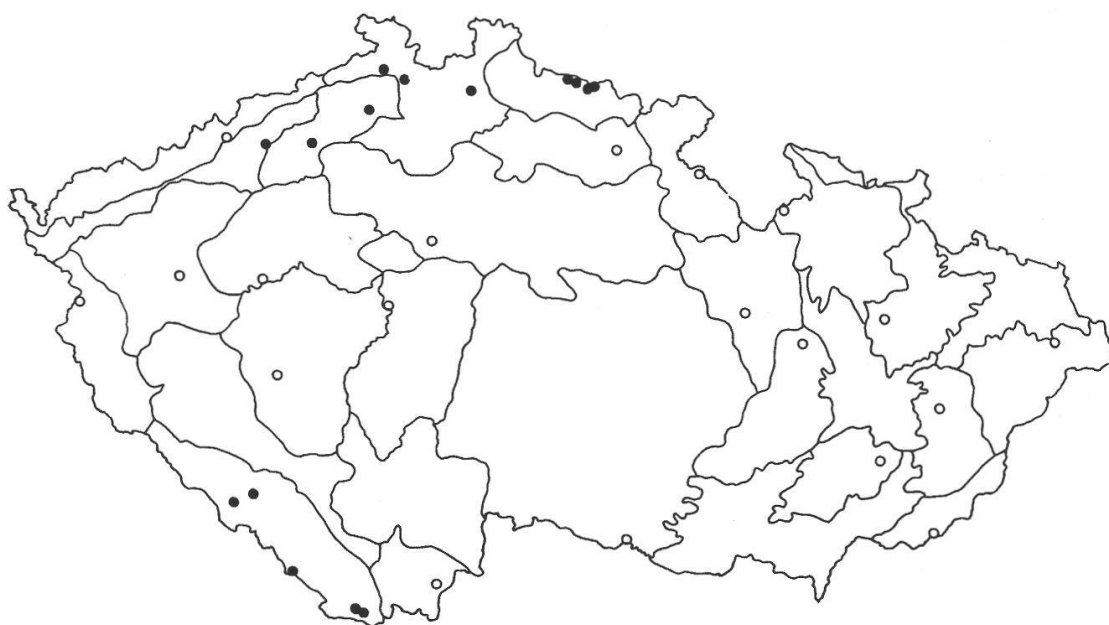


Fig. 4 - Modell localities for pitfall trapping in stony debris in faunistic districts of Czech Republic. ● - made, ○ - planed..

- (5) The temperature measurement inside of debris with stuck-in perforated plastic tubes was realised (RUZICKA 1990). All-year temperature fluctuations will be examined.
- (6) For the current results see RUZICKA (1990).

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Further crossing experiments in *Latrodectus* species (Araneida: Theridiidae)

par
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Summary: In continuation of earlier tests, crossing experiments were performed with the following species: *Latrodectus lugubris* (Dufour, 1820), Kazakhstan, *L. tredecimguttatus* (Rossi, 1790), Corsica, *L. hesperus* Chamberlin & Ivie, 1935, California, *L. geometricus* C. L. Koch, 1841, South Africa, Argentina, *L. g. obscurior* Dahl 1902, Madagascar, and *L. hasselti* Thorell, 1870, Australia.

Variably, large males of *L. 13-guttatus* did not copulate with a female of *L. lugubris*, whereas a small male of *L. hesperus* mated with this female on the 18th day of the trial. The male of *L. lugubris* did not copulate with females of *L. geometricus* (Argentina) and *L. hasselti*. However, a very intensive courtship behaviour could be observed with females of these species. Males of *L. geometricus* did not copulate with females of *L. g. obscurior*. The male of *L. hesperus* did not react on females of *L. geometricus* and *L. g. obscurior*. A female of *L. g. obscurior* which had killed a male of *L. geometricus* before, copulated totally unexpectedly with a large male of *L. 13-guttatus*. This male and several other males of this species did not react to females of *L. geometricus*, or only weak to females of *L. hesperus*. There was no reaction between males of *L. geometricus* and females of *L. hesperus* and *L. lugubris*, but a very intensive courtship of the male of *L. lugubris* in front of a female of *L. hesperus*. One day later the male was found dead and wrapped (after copulation?). The female of *L. hesperus* constructed an egg-sac with infertile eggs. After the successful matings between *L. hesperus* x *L. lugubris* and *L. 13-guttatus* x *L. g. obscurior* no egg laying occurred however.

Zusammenfassung: In Fortsetzung früherer Versuche wurden Kreuzungsexperimente mit folgenden Spezies durchgeführt: *Latrodectus lugubris* (Kasachstan), *L. tredecimguttatus* (Korsika), *L. hesperus* (Kalifornien), *L. geometricus* (Südafrika, Argentinien),

L. g. obscurior (Madagaskar) und *L. hasselti* (Australien).

Während verschieden große Männchen von *L. 13-guttatus* nicht mit dem Weibchen von *L. lugubris* kopulierten, wurde dieses nach 17 Tagen Versuchsdauer von einem kleinen *L. hesperus*-Männchen begattet. Das *L. lugubris*-Männchen kopulierte nicht mit Weibchen von *L. geometricus* (Argentinien) und *L. hasselti*. Jedoch wurde sehr intensives Werbeverhalten vor Weibchen dieser Arten beobachtet. Männchen von *L. geometricus* kopulierten nicht mit Weibchen von *L. g. obscurior*. Das Männchen von *L. hesperus* reagierte nicht auf Weibchen von *L. geometricus* und *L. g. obscurior*. Ein *L.g.obscurior*-Weibchen, das zuvor ein *L. geometricus*-Männchen getötet hatte, wurde völlig unerwartet von einem großen *L. 13-guttatus*-Männchen begattet. Dieses und andere *L.13-guttatus*-Männchen reagierten nicht auf *L. geometricus*-Weibchen oder nur schwach auf Weibchen von *L. hesperus*. Es erfolgte auch keine Reaktion von *L. geometricus*-Männchen auf Weibchen von *L. hesperus* oder auf das *L. lugubris*-Weibchen. Das *L. lugubris*-Männchen warb sehr intensiv vor dem *L. hesperus*-Weibchen. Einen Tag später wurde es tot und eingesponnen aufgefunden (nach Kopulation?). Das *L. hesperus*-Weibchen baute einen Eierkokon, der unbefruchtete Eier enthielt. Nach den gelungenen Paarungen von *L. hesperus* x *L. lugubris* und *L. 13-guttatus* x *L. g. obscurior* fand keine Herstellung von Eikokons statt.

1. INTRODUCTION

In a previous investigation (SCHMIDT 1990 b) it could be shown that sexual reaction between different species of *Latrodectus* occurs within the *mactans*-group only. There the different degrees of sexual attraction confirm the rank of relationship and reflect the genetical relations between single species in a similar way as morphological criteria do.

The courtship behaviour in american *Latrodectus* species was reported exactly by KASTON (1970). On that occasion he also mentioned the curious gathering up of threads of the female's web in concentrated bands and sheets by the male, a behaviour that can last some days especially in all cases where the male courted in vain. In some cases this is the only sign of courtship at all, particularly with large "nervous" males, as I could show in earlier experiments (SCHMIDT 1990 b).

According to KASTON, it was impossible to cross *L. mactans* (Fabricius, 1775) with *L. variolus* Walckenaue, 1837, and *L. variolus* with *L. hesperus*. 3 of 27 attempts between *L. mactans* and *L. hesperus* only were successful. But there was no development of eggs. Other unsuccessful trials between 6 different species of *Latrodectus* in Argentina were reported by ABALOS (1962) and ABALOS & BAEZ (1967) and between *L. mactans* and *L. tredecimguttatus* by LEVI (1966) and MARTINDALE & NEWLANDS (1982).

In these cases, after matings no fertile eggs were produced. The same result brought out from matings between *L. tredecimguttatus* males and *L. hasselti* females (TES-

MOINGT 1987, cit. SCHMIDT 1990 b). Only trials with *L. hasselti* males and *L. tredecimguttatus* females WEICKMANN (1988) could get offspring. The same could be proved in matings between *L. hasselti* and *L. katipo* Powell, 1870 (FORSTER, pers. comm. 1989).

2. MATERIAL AND METHODS

The trials were performed with 1 female of *L. lugubris* from Kazakhstan, 1 male of its offspring, 3 females and 1 male of *L. hesperus* from California, 1 female of *L. geometricus* from Argentina, 1 female and 1 male from South Africa, 2 females of *L. g. obscurior* from Madagascar, 4 males of *L. tredecimguttatus* from Corsica and 1 female of *L. hasselti* from Australia (offspring).

The caging and rearing was described in a previous paper (SCHMIDT 1990 b). The identification of the *Latrodectus* species was done according to KATNER (1956), LEVI (1959), KASTON (1970) and SOUTHCOTT (1976).

In all cases the males were added to the female for a specified time depending on the sexual activity, usually at least 1 week.

3. RESULTS

L. lugubris male x *L. hesperus* female

The very large male started its courtship immediately by cutting and gathering up the threads of the female's web which were wrapped. In doing so it came up to the female within a few millimeters, reacted very intensely by aroused jerking, was chased away by the female, started again its courtship, was chased away once again and so on. The next day the male was found enwrapped up. It is not clear whether a copulation took place during the night or not. The female built an egg-sac with infertilized eggs 3 weeks later.

L. lugubris male x *L. geometricus* female

Very intense jerking in front of the female from Argentina for 2 hours. The female chased up the male and tracked it. Repeated courtship behaviour including plucking the threads.

L. lugubris male x *L. hasselti* female

The male immediately approached the female and showed intense jerking and plucking movements, but also showed the curious cutting of threads of the female's web which were wrapped up. Despite the tracking by the female the courtship was continued. The partners were separated 4 hours later because the female was absolutely uninterested.

L. hesperus male x *L. lugubris* female

On November 26, 1990 one male of *L. hesperus* and *L. tredecim-guttatus* each were put at the margin of the web of *L. lugubris*. The male of *L. hesperus* left the web uninterested some hours later and stayed outside up to 10 days. Then it approached the female up to 3 cm, once again without courtship reactions. On December 12, 10 h. a. m. the copulation took place in the dome-shaped retreat of the female's web. The first series of copulations lasted 22 min. The female made weak enwrapping movements at the end of this period. The next series lasted 17 min. Then the male squatted on the belly of the female for hours. Next copulation series: 13,26 h. 15,55 h: the male left the female. 18.30 h: Courtship behaviour and spinning round the abdomen of the female, then copulation. 20.00 h: The male left the body of the female, but stayed in the retreat of the female's web. The female was very peaceful. On the next morning I found the male outside of the female's web, with only 6 legs. One day later it died from exhaustion.

L. hesperus male x *L. hesperus* female

Normal copulation and fertile egg.

L. hesperus male x *L. geometricus* females

No courtship behaviour was seen.

L. hesperus male x *L. geometricus obscurior* females

No sexual reaction.

L. geometricus male x *L. geometricus* female

Normal copulation without killing the male.

L. geometricus male x *L. geometricus obscurior* females

Courtship behaviour could be observed, but the females drove away the male and reacted very aggressively. One day later the once more courting male was wrapped up and killed.

L. geometricus male x *L. lugubris* female

No reaction between the partners.

L. geometricus male x *L. hesperus* females

No sexual behaviour.

L. tredecimguttatus males x *L. lugubris* female

No male produced any kind of intense courtship behaviour. Some approached the female and sat nearby, other demonstrated total lack of interest.

L. tredecimguttatus males x *L. hesperus* females

In 3 cases, no reaction. In one case, after about 34 hours male and female sat opposite each other peacefully.

L. tredecimguttatus males x *L. geometricus* females

No reaction besides searching for the female and sitting closely by it (1 cm distance). In one case weak jerking and plucking.

L. tredecimguttatus males x *L. geometricus obscurior* females

In 3 cases, no sexual reaction. In one case, on December 25, 11 h a. m., violent courting appeared immediately after touching the threads of the female, including spinning round the female and attempts to copulate. The very large male could mate the female after the 5th attempt (11.58 h). 30 seconds later the female drove away the male by its 4th leg. At 12.00 h renewed spinning round the female and further attempts to copulate. 12.12 h: renewed insertion of the palp for about 30 seconds. Then the male was chased away by the 4th leg of the female. The partners stayed together up to 4 p. m. For a longer time the male sat on the back of the female.

On December 27, the female constructed its third egg-sac without the green wrapping and the spikes. The eggs remained infertilized.

L. tredecimguttatus males x *L. hasselti* female

TESMOINGT succeeded in hybridizing in 2 of 7 cases. The duration of the copulations lasted up to 4 hours. Then the males were killed by the females. The egg-sacs constructed after the copulations were infertilized.



	L.t.	L.L.	L.c.	L.e.	L.h.	L.he.	L.g.	L.g.o.	L.p.
<i>L. tredecimguttatus</i>	4	1	-	-	3 ¹⁾	0-1	1	3	-
<i>L. lugubris</i>	-	4	-	-	2	2 (3?)	2	2	-
<i>L. hasselti</i>	4 ²⁾	2	1 ³⁾	2	4	-	0	-	0
<i>L. hesperus</i>	-	3	-	-	-	4	0	0	-
<i>L. geometricus</i>	-	0	-	0	0	0	4	1-2	0
<i>L. antheratus</i>	-	-	-	0	-	-	-	-	0

See legend next page

- = not examined
- 0 = no reaction
- 1 = weak reactions: searching for female and sitting closely by it
- 2 = violent reaction, including intense courting, spinning round the female and attempts to copulate
- 3 = copulation, but no fertile eggs
- 4 = normal copulation and fertile eggs.

- L. t. = *Latrodectus tredecimguttatus*
- L. L. = *Latrodectus lugubris*
- L. c. = *Latrodectus cinctus* (= *L. indistinctus*)
- L. e. = *Latrodectus erythromelas*
- L. h. = *Latrodectus hasselti*
- L. he. = *Latrodectus hesperus*
- L. g. = *Latrodectus geometricus*
- L. g. o. = *Latrodectus geometricus obscurior*
- L. p. = *Latrodectus pallidus*

¹⁾ Termoingt

²⁾ Weickmann

³⁾ Bloss

4. DISCUSSION

In contrast to earlier experiments it could be shown that not only within the *L. mactans*-group courtship reactions and copulations between different species occur, but also between members of the *mactans*- and the *geometricus*-group. Therefore it can be supposed that not only in the *L. mactans*-group but also generally in the genus *Latrodectus* the process of speciation has not been completed yet. It seems that there are differences between *L. tredecimguttatus* and *L. lugubris* in the courtship behaviour. It was impossible to bring about matings between these species. These two members of the *mactans*-group have to be considered as true species. They differ in the pH of toxins (WEICKMANN 1988), in the body size, in the coloration and in the geographical distribution (SCHMIDT 1990 a). In *L. geometricus* it is very likely that populations from different regions of the earth have not only variable body color and markings, different shape and color of egg-sacs, but also variable sex pheromones. This has to be clarified in further experiments. Anyway, it was impossible to cross *L. geometricus* with *L. g. obscurior*. A further point has to be mentioned: not only in *L. hasselti* and *L. geometricus* are there differences in the sexual behaviour

depending on the size of the males. This seems to be the case also in other species of this genus. Therefore one may only compare the results of experiments with males of similar body size.

5. CONCLUSIONS

The sexual behaviour can reflect the degree of genetic relationship between different species within the genus *Latrodectus* in all cases, in which males and females communicate sexually with each other. The courting behaviour of the males itself can be misinterpreted because males of *Latrodectus* in some cases even court females of *Steatoda* (WEICKMANN, in litteris, 1991). For instance, a male of *L. hesperus* attempted to copulate with a female of *S. grossa* (in trials of my own a male of *L. lugubris* did not court a female of *S. bipunctata*). Not only the *L. mactans*-group but also the *L. geometricus*-group represents a complex of species or subspecies.

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Temporal species serie of web-spiders (Arachnida: Araneae) as a result of pine tree bark-structure

par
Ulrich Simon

Summary: In 1987, one group of 40 years old pine-trees (*Pinus silvestris* L.) and another group of 120 years old pines were investigated with arboreal photo-electors and arboreal pitfall-traps, 2 meters above ground.

Species with a high number of individuals showed a close serie of peaks on the old stems. On the young pines, peaks appear at a different time and the number of species living there is lower.

This is discussed as a result of the well structured bark of old pines offering its inhabitants, conditions that even ground living spiders can use.

1. INTRODUCTION

There is a lot of research concerning the fauna of tree stems (e. g. FUNKE 1977b, FUNKE & SAMMER 1980, ALBERT 1976 and 1982). But only a few of them are concerned with functional aspects of the bark (NICOLAI 1986). For spiders habitat-structure is one of the most important abiotic factors: to fix the net, to be hidden from predators, because of microclimatical conditions, etc.

In this work the influences of *Pinus silvestris* L. age and of its bark structure on species composition and the activity of spiders during the year on the bark are to be shown.

2. MATERIAL AND METHODS

The investigation was carried out with arboreal photo-electors (after FUNKE 1971) and arboreal pitfall traps at two groups of pines each of three trees (*Pinus silvestris* L.). The sampling period did last from May 7, 1987 to December 10, 1987.

The trees of the first group were about 120 years old, the ones of the second about 40 years old. At a height of 2 meters, two, three or four of each traps were installed as a sleeve around the stem. The spiders were captured in saturated picric acid. Every week all traps were emptied, the animals were put into ethanol (70%) and determined. Spiders were determined using GRIMM 1985, LOCKET & MILLIDGE 1951/53, LOCKET, MILLIDGE & MERRET 1974, ROBERTS 1987, WIEHLE 1956.

3. RESULTS

One can see two seasons of spider-activity on pine trees stems, one in late spring and early summer, and one in autumn. Both of them last the same time, about 10 weeks (figure 1).

In the first season, the number of species with a proportion of more than 1% of all sampled adult spiders, is higher (15 species) than in the second season (4 species)(table 1).

The series of species in both seasons are different comparing the old stems (figure 1a) with the young ones (figure 1b). The individual-rich species in spring and early summer show a very close serie of maxima in contrast to the species in autumn. As a result there is a peak every week for at least one of the species occuring on the stems of old pines in the first season. Since in autumn there are only a few species on the bark of pines the maxima of abundance are only every two weeks (figures 1a and b) or more.

On the young pines the serie of species in spring is not similar and species have another row of appearance (figure 1b).

4. DISCUSSION

The results show the existence of limiting factors for the activity of spiders on pine-tree bark. Already known factors are temperature, climate and radiation (NICOLAI 1986). The two investigated stands possess only a few differences in temperature and atmospheric humidity. Global radiation is higher in the old stand (v. STÜLPNAGEL, pers. comm.).

Therefore the main factor for the observed difference in spider population must be the structure of the bark. Older pines possess a well structured bark with a lot of clefts and chinks. Spiders can use them to be hidden from predators (e. g. birds) or for the their microclimatical conditions (e. g. radiation may heat the bark and produce higher

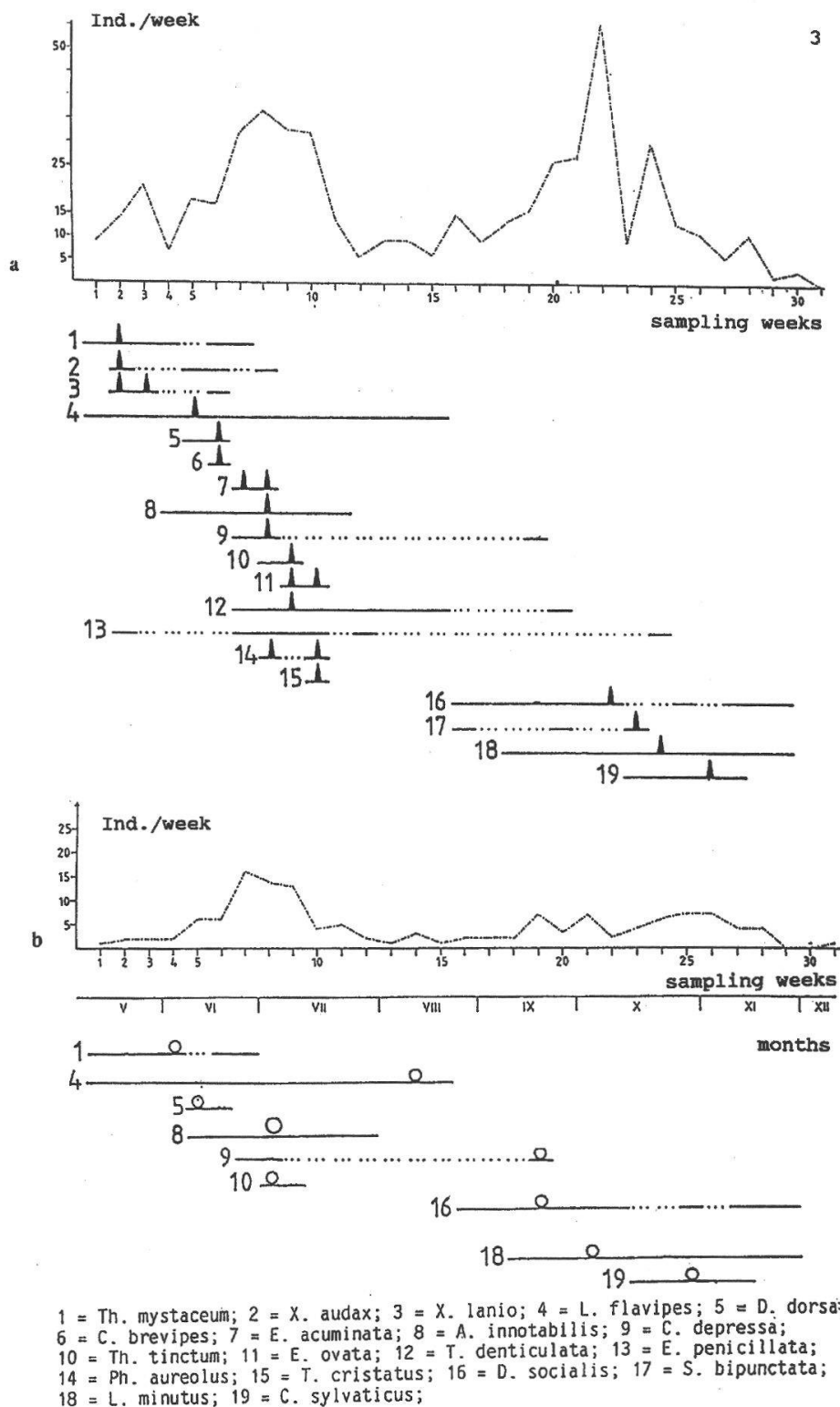


Fig. 1 - The occurrence of adults spider on the stems of old pine trees (a) and young pines (b). Lines mean the appearance of the species during sampling period; triangles = maximum of species activity on the old pines - circles = maximum of species activity on the young pines.

Table I

Species found on bark of pines (more than 5 individuals), separated into the two seasons and the two aged tree-groups

name of the species	prefered habitat	old trees	young trees
appearing in spring			
<i>Theridion mystaceum</i>	trees	yes	yes
<i>Xysticus audax</i>	trees	yes	no
<i>Xysticus lanio</i>	tree/ground	yes	no
<i>Lepthyphantes flavipes</i>	ground	yes	yes
<i>Moebelia penicillata</i>	trees	no	yes
<i>Entelecara acuminata</i>	tree/ground	yes	no
<i>Meioneta innotabilis</i>	trees	yes	yes
<i>Textrix denticulata</i>	tree/ground	yes	no
<i>Coriarachne depressa</i>	trees	yes	yes
<i>Diaea dorsata</i>	tree/ground	yes	yes
<i>Theridion tinctum</i>	trees	yes	no
<i>Enoplognatha ovata</i>	ground	yes	no
<i>Philodromus aureolus</i>	trees	yes	no
<i>Clubiona brevipes</i>	trees	yes	no
<i>Trematocephalus cristatus</i>	trees	yes	no
appearing in autumn			
<i>Drapetisca socialis</i>	trees	yes	yes
<i>Steatoda bipunctata</i>	trees	yes	no
<i>Lepthyphantes minutus</i>	ground	yes	yes
<i>Centromerus sylvaticus</i>	ground	yes	yes

temperatures, but in the clefts humidity may be very high as well). This may lead to an addition of two positive factors for spiders!

Owing to this a high number of ground-living spiders (PLATEN 1984) are able to enter this habitat and add to the bark-living spiders (e. g. *Lepthyphantes flavipes*, *Centromerus sylvaticus*). The result is the described close serie of abundance's maxima. Further investigations will show until which level ground-living spiders can use bark as that supposed "supplementary habitat".

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Zur Beutetierspezifität des Giftes von *Cupiennius salei* (Araneae: Ctenidae)

par
André Studer & Wolfgang Nentwig

Summary: When the venom of the ctenid spider *Cupiennius salei* is injected into different insect species, the insects show a different sensitivity to the venom which can be measured as LD-50 values. Some flies are 1000 times more sensible than beetles or ants. The more sensitive species are more often accepted as prey by the spider than unsensible ones. The LD-50 values are supported by results which base on a respirometric method. This allows to measure very precisely the time-dependent effect of a venom and shows different recovery possibilities among the insects tested.

1. EINLEITUNG

Is vor wenigen Jahren beschränkten sich die Arbeiten mit Spinnengift beinahe vollständig auf einige humantoxische Arten. Dabei stand vor allem die Wirkung des Giftes auf Wirbeltiere im Vordergrund. Nahrungsökologische Aspekte in Zusammenhang mit Spinnengift sind bisher nur wenig erforscht. Interessante Gesichtspunkte ergaben sich bei Untersuchungen von HELLER (1974) und COUVREUR (1977) mit Gift von ausschliesslich ameisenfressenden Spinnen, bei denen festgestellt wurde, dass das Gift auf andere Insekten nur sehr schwach oder überhaupt nicht lähmend wirkt. In der folgenden Arbeit soll die Wirkung des Giftes von *Cupiennius salei*, einer polyphagen Ctenide, auf verschiedene Insekten untersucht werden.

2. MATERIAL UND METHODEN

2.1 Giftgewinnung

Zur Giftgewinnung wurden adulte Weibchen verwendet, die sich seit höchstens 5.5 Monaten das letzte Mal gehäutet hatten. Die Tiere wurden betäubt, fixiert und elektrisch zur Abgabe des Giftes veranlasst (MALLI 1991), wobei Intervalle von mindestens zwei Wochen zwischen den einzelnen Giftentnahmen bei derselben Spinne eingehalten wurden.

2.2 LD-50 Bestimmung

Das gewonnene Gift wurde mit Insektenringer verdünnt und den in Tabelle 1 genannten Arten eingespritzt. So wurde rechnerisch die LD-50, die Giftdosis, die nach 24 h auf 50% der Tiere letal wirkt, ermittelt. Die getesteten Insekten wurden nach Gewicht ausgewählt. Dieses durfte maximal 10% nach oben oder unten variieren. Die Giftinjektion wurde zwischen Coxa und Trochanter des rechten Hinterbeines vorgenommen. Nur die Ameisen erhielten die Einspritzung wegen ihrer geringen Grösse dorsal zwischen das 2. und 3. Abdominalsegment und die Käfer *Chrysomela menthastri*, *Agelastica alni* und *Poecilus cupreus* dorsal zwischen Thorax und Abdomen.

Ordnung	Art	Gewicht [mg]	LD50/KG [nl/mg]	Reaktion
Coleoptera	<i>Chrysomela menthastri</i>	62	>>8,06	-
	<i>Agelastica alni</i>	33,5	5,97	-
	<i>Poecilus cupreus</i>	95	3,6	-
	<i>Tenebrio molitor</i>	130	3,85	-
Saltatoria	<i>Acheta domesticus</i> M	300	2,06	+/-
	<i>Gryllus spec.</i>	810	1,61	+
	<i>Grillodes sigillatus</i> M	70,2	0,312	++
	<i>Grillodes sigillatus</i> W	91,4	0,305	++
Hymenoptera	<i>Messor rufitarsis</i>	6,5	11,4	-
	<i>Myrmica spec.</i>	2,4	24,4	-
	<i>Formica rufa</i>	11,5	6,25	-
	<i>Lasius niger</i>	2,16	1,41	+
Diptera	<i>Protophormia spec.</i>	44	0,011	+++
	<i>Drosophila melanogaster</i>	1,96	0,017	+++
Neuroptera	<i>Chrysoperla carnea</i>	13	0,411	++

Tab. 1 - LD-50-Werte der verschiedenen Insektenarten; M Männchen; W Weibchen; KG Körpergewicht; Reaktion auf die Giftinjektion: - nicht sensibel (>2.5 nl Gift/mg Körpergewicht), +/- kaum sensibel, + sensibel (1-2 nl/mg), ++ sehr sensibel (0.1-1 nl/mg), +++ überaus empfindlich (<0.1 nl/mg).

2.3 Respirometrie

Für eine respirometrische Erfassung der durch das injizierte Gift verursachten zunehmenden Reduktion der Stoffwechselintensität wurde eine Apparatur entwickelt, bei der ein neues Messverfahren benutzt wurde. Eine opto-akustische Messzelle der Firma Arित्रon wurde zur CO_2 -Messung in ein geschlossenes Kreislaufsystem eingebaut (Abbildung 1). Mittels einer Membranpumpe zwischen dem Messgefäß und der Messzelle wird die Luft im Kreis gepumpt. Bei der eigentlichen Messung werden die Ventile vor und nach der Messzelle geschlossen. Nun wird über eine Infrarot-Lichtquelle gepulstes Licht in die Zelle abgegeben. An der Seite, an der dieses in die Zelle gelangt, ist ein Interferenzfilter angebracht. Dieser ist nur für Licht mit einer Wellenlänge von 600 nm durchlässig. Bei dieser Wellenlänge werden spezifisch die CO_2 -Moleküle zu Schwingungen angeregt. Die Schwingungen führen zu einer Ausdehnung des Gases und damit zu einer Druckerhöhung innerhalb der Messzelle. Diese wird als Schall mit einer empfindlichen Mikrophonmembran, die der Zelle anliegt, registriert. Die Ventile, die Lichtquelle und das Mikrophon sind an eine zur Messzelle gehörende Steuerung gekoppelt. Die Steuerelektronik ist an eine PC-Interfacekarte angeschlossen, die ihrerseits mit einem PC als Datenlogger verbunden ist.

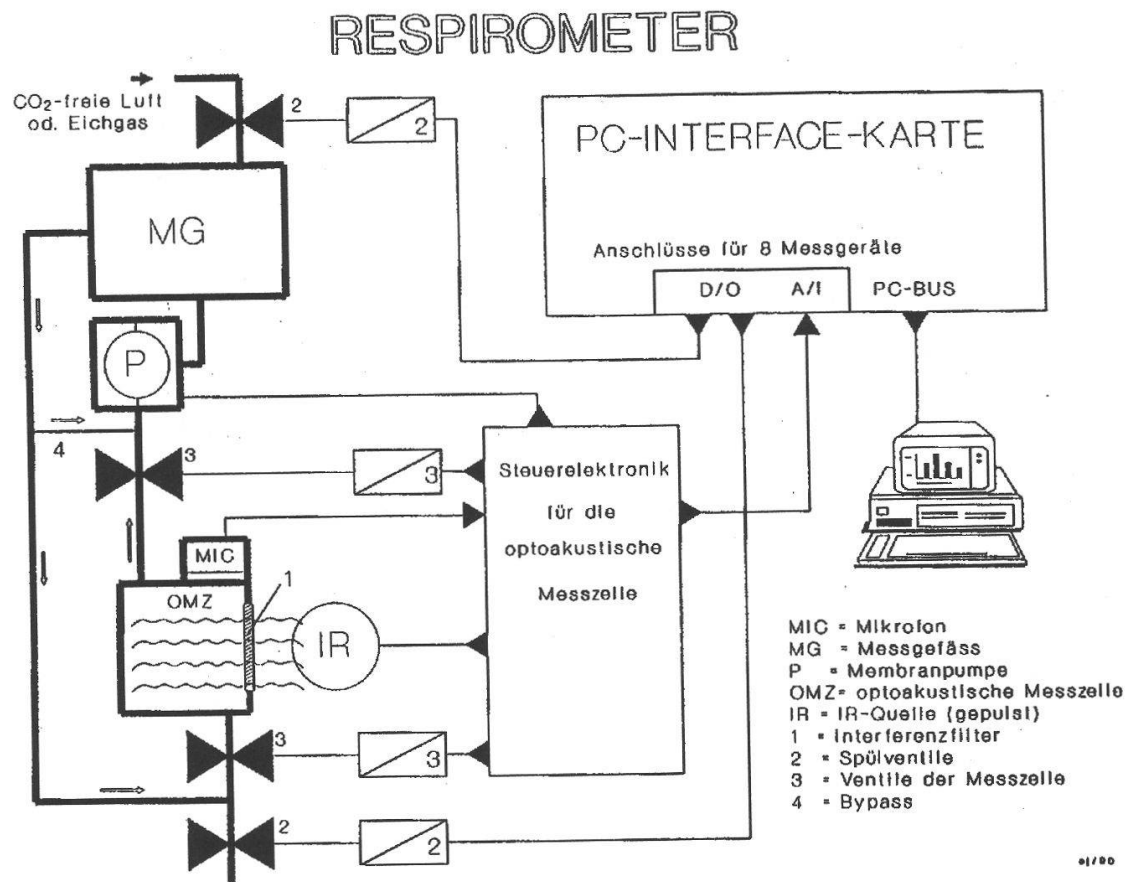


Abb. 1 - Schematische Übersicht eines CO_2 -Respirometers nach dem opto-akustischen Messprinzip. Weitere Erläuterungen im Text.

Eine geeignete elektronische Auswertung (Integration und Ausfiltrierung der Druckimpulse) erlaubt Rückschlüsse auf den CO₂-Gehalt in ppm. Insgesamt standen fünf Geräte zur Verfügung, die so geeicht wurden, dass der Messbereich, in dem gearbeitet werden konnte, 0 - 1000 ppm betrug. Zwei weitere Magnetventile ermöglichten eine Spülung des Messgefäßes mit CO₂-freier Luft von aussen.

3. ERGEBNISSE UND DISKUSSION

3.1 LD-50-Werte

Die LD-50-Werte der einzelnen Insektenarten sind in Tabelle 1 ersichtlich. Dabei zeigt sich, dass die Käfer und Ameisen mit Ausnahme von *Lasius niger* viel höhere LD-50 Werte pro mg Körpergewicht aufweisen als die anderen Insekten. Relativ uneinheitlich und empfindlicher reagieren die Grillen. Weitaus am sensibelsten sind die Fliegen mit einer LD-50 von 0,017 nl Gift für *Drosophila melanogaster* und 0,011 nl für *Protophormia spec.* Erstaunlicherweise sind diese über 1000 mal empfindlicher als die Ameisen. Das lässt vermuten, dass bei den verschiedenen Insekten das Gift auch physiologisch unterschiedlich wirkt.

3.2 Frassversuche

Frassversuche mit 4 Insektenarten ergaben weitere, bemerkenswerte Resultate: Das Heimchen *Acheta domesticus* und die Fliege *Protophormia spec.* wurden zu 98 bzw. 88% gefressen, während der Mehlkäfer *Tenebrio molitor* und die Ameise *Messor rufitarsis* nur zu 11 bzw. 18% als Beute akzeptiert wurden. Die Spinne betastete die Tiere zwar mit den Pedipalpen, liess aber nach 1-2 s meist wieder von der vermeintlichen Beute ab und kümmerte sich in der Folge nicht mehr um diese. Diese Beobachtungen stimmen mit Angaben von BARTH & SEYFARTH (1979) überein, die als natürliche Beutetiere von *Cupiennius salei* in Mittelamerika u.a. Vertreter der Grillen und Fliegen angeben, nicht aber Käfer oder Ameisen. Zudem musste die Spinne, um Arten dieser beiden Insektengruppen schnell zu paralysieren, diesen ein Vielfaches der LD-50 einspritzen, während beispielsweise *Acheta domesticus* schon nach einer Injektion von weniger als 1/5 der LD-50 in 2 min völlig gelähmt war. Dies sind Hinweise, dass die Giftwirkung bei der Beutewahl der Spinne eine nicht zu unterschätzende Rolle spielen könnte, bzw. das Gift auf häufige Beutetiergruppen besonders schnell wirkt und hier optimiert ist.

3.3 Respirometrische Methode

Eine feinere Methode zur Untersuchung der Wirkung des Giftes gestattet das oben erwähnte Prinzip der Respirometrie. Registriert werden die CO₂-Konzentrationen zu Beginn und am Ende einer bestimmtem Zeitspanne. Durch Subtraktion der beiden Werte erhält man die CO₂-Produktion des Tieres im Messgefäß. Gegenüber der herkömmlichen Warburg-Methode besitzt dieses Verfahren mehrere Vorteile: es kön-

nen Messgefäße von kleinem Volumen gewählt werden, was die Genauigkeit der Resultate entscheidend erhöht und Messungen im Bereiche von wenigen ppm ermöglicht. Der Zeitraum, während dem von einem Organismus CO_2 produziert wird, kann sehr kurz gehalten werden und Langzeitmessungen von mehreren Stunden bei gleichen Druckverhältnissen im Messgefäß sind kein Problem mehr.

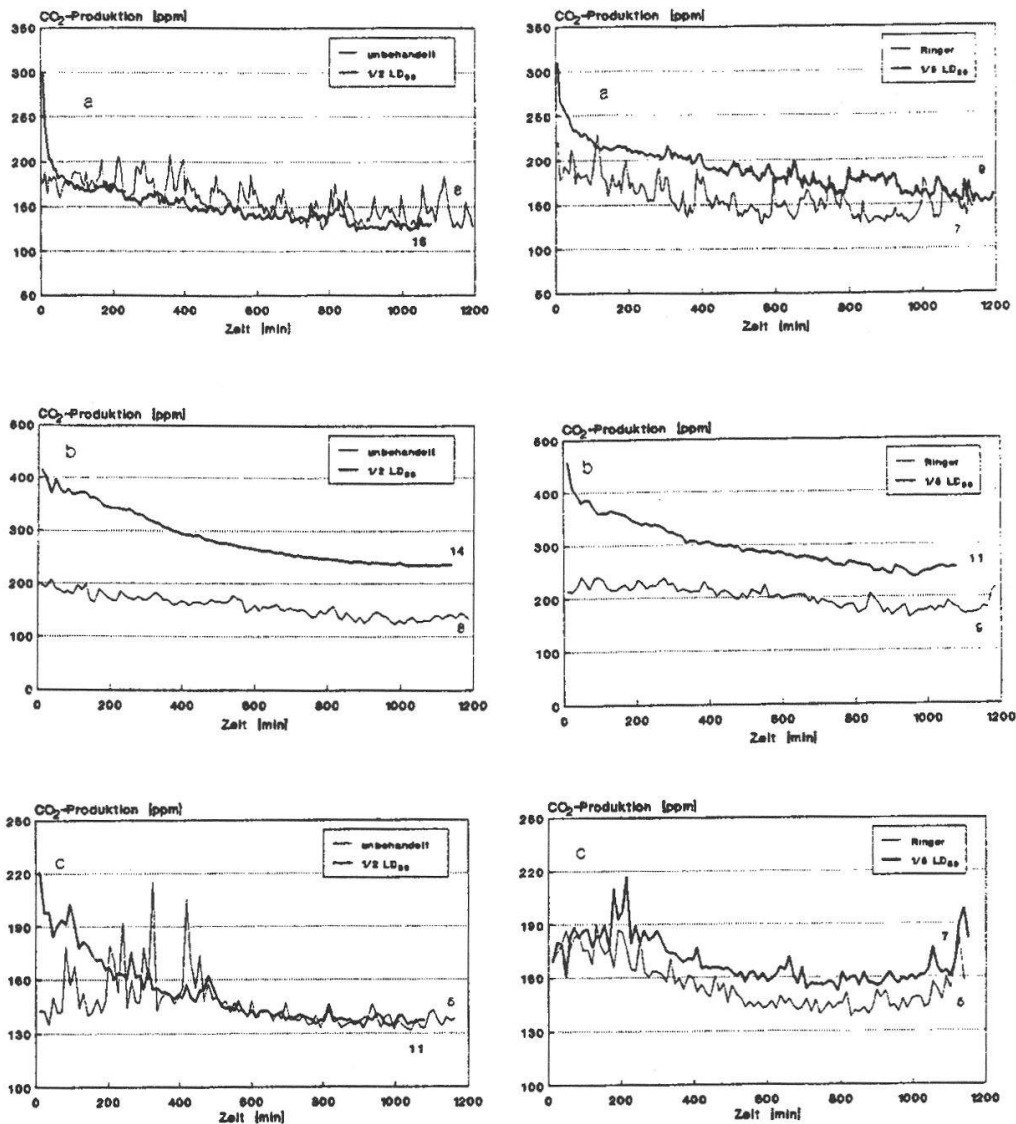


Abb. 2- CO_2 -Produktion von: a. *Acheta domesticus* (Messintervalle 3 min); b. *Tenebrio molitor* (Messintervalle 5 min); c. *Protophormia spec.* (Messintervalle 5 min). Die Zahlen ober- und unterhalb der Mittelwertkurven entsprechen der Anzahl der getesteten Tiere.

3.4 Respirometrisch gemessene Giftwirkung

In unseren Versuchen massen wir die CO₂-Abgabe einiger Insekten nach dem Einspritzen von Ringer und von zwei subletalen Giftdosen von 1/2 und 1/5 LD-50. Allen drei Insektenarten ist die unmittelbare Erhöhung der CO₂-Produktion nach der Giftinjektion bis z.T. über 100 % gemeinsam (Abbildung 3). Sie ist deutlich abhängig von der verabreichten Giftmenge. Das rasche Absinken der beiden CO₂-Verläufe bei *Acheta domesticus* zeigt, dass beide Giftdosen einen ähnlich starken Effekt haben. Bei *Tenebrio molitor* wirkt das Gift auf eine andere Weise als bei dem Heimchen. Der Käfer weist bei beiden Giftdosen gegen Ende des Versuchs eine immer noch stark erhöhte Atmung auf, was einerseits auf eine schwächere Giftwirkung zurückzuführen ist und andererseits als Erholungserscheinung aufgefasst werden kann. Das würde mit den Beobachtungen übereinstimmen, dass sich die Käfer nach den ca. 20 h dauernden Versuchen oft tatsächlich von der Giftwirkung erholt hatten. Die Fliege *Protophormia spec.* reagiert auf beide injizierten Giftdosen am wenigsten. Bei 1/5 LD-50 ist eine nur geringfügige Erhöhung der Atmung während des ganzen Experimentes zu sehen, was aber auch auf die geringe Anzahl der getesteten Tiere zurückführbar sein kann. Bei der stärkeren Dosis ist zwar eine klar erhöhte CO₂-Produktion sichtbar, sie erreicht aber nach etwa 400 min wieder das Niveau der Kontrollversuche mit Ringer. Eine ausführlichere Darstellung der statistischen Regressionsanalysen der respirometrisch erhaltenen Kurvenverläufe findet sich bei STUDER (1991).

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**Chingis Tarabaev - Karakurt (spider genus *Latrodectus*) in
Kazakhstan:
distribution and problem of victim registration**

par
Chingis Tarabaev

1. INTRODUCTION

Since the development of medical parasitology at the end of the last century and at the beginning of the current one, the spiders of genus *Latrodectus* ("karakurt" in Turcic languages) had drawn the particular attention of scientists. Within the USSR territory karakurt has been studied especially thoroughly by ROSSIKOV (1898, 1904), PAVLOVSKY (1931, 1942), PAVLOVSKY GIZHITSKY (1935), MARIKOVSKY (1956).

At the beginning of our century, in the times of nomadic life of Kazakhs, Kirghizians and other people of Soviet Middle Asia, large scaled karakurt's bites of people and cattle have occurred. Thus, according to ROSSIKOV (1898), in the little Kazalinsk District near Aral Sea in 1896 there were 349 people bitten by karakurt (11 of them died) and 1035 domestic animals bitten with 340 mortal cases. In western Kazakhstan the number of bitten people in the same year had reached 1.000 with more than 100 mortal cases. Often people had to migrate from rich pasture territories for reasons of the high density of karakurt there. During nomadic life one was forced to take care of oneself, so the people knew karakurt very well.

Since the development of civilization the life of people inhabiting Middle-Asian and Kazakhstan region have changed considerably. Medicine gradually took the care of people's health. However, information about karakurt damage had become more and more poor and practically faded away since the thirties, when Professor MARIKOVSKY began the investigations of karakurt's biology. But nobody carried out any registration or thorough work on discovery of karakurt bites of people and cattle within the USSR territory. One could think that rapid urbanization of environment could have caused the decrease of karakurt's abundance and damage. But such a view is far from reality.

2. RESULTS

The investigations we carried out during the last 5 years on karakurt's present condition, show that its abundance can locally be very high: in some points it approaches an average density of 1 specimen per 1 square metre. Besides, the places of high abundance are numerous enough and scattered over the whole distribution's area of karakurt. They are often situated just near people's settlements, so that karakurt is often in contact with people and cattle.

3. DISCUSSION

We have found the following explanation for the lack of information concurring the damages caused by the karakurt. Where the species is extremely abundant and where the possibility of people's being in contact with it is very high, we could not find any doctor or epidemiologist who knew karakurt or of its high abundance in the territory being inspected by him. It is obvious, that people and cattle are still rather frequently in contact with karakurt, but the cases in which people and cattle are poisoned by the last are wrongly diagnosed by doctors and other specialists. Local inhabitants themselves seem to rely upon health services, they have little knowledge about

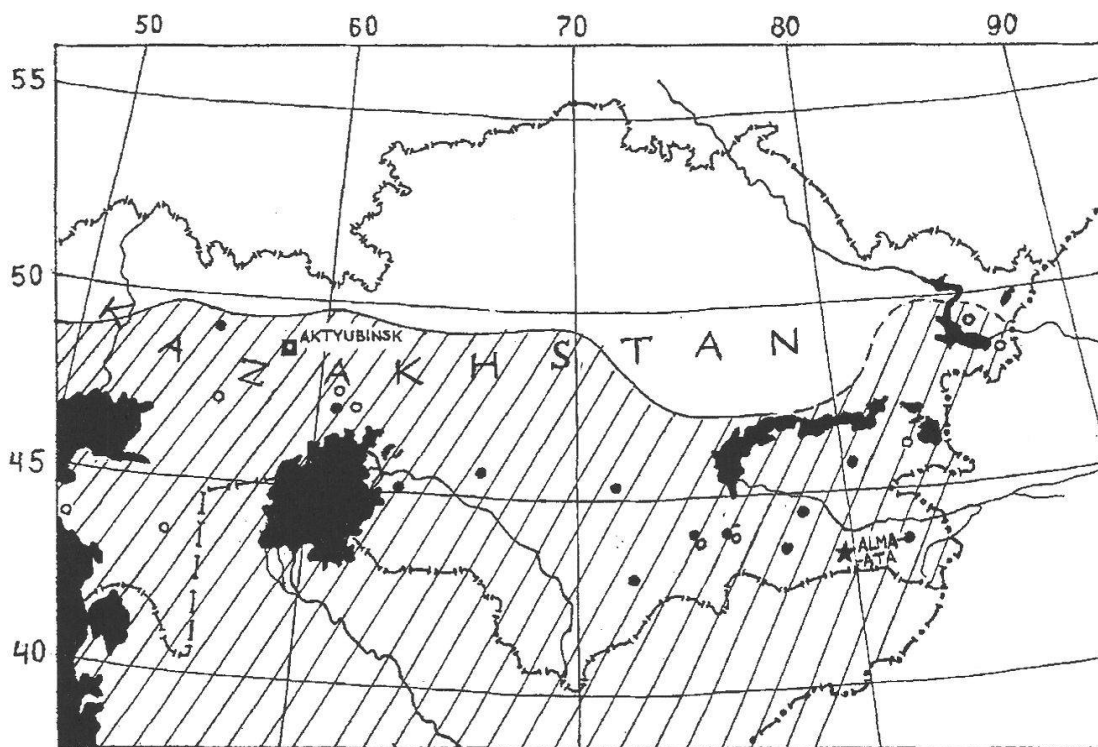


Fig. 1 - Distribution of karakurt over the territory of Kazakhstan

— - area borders after Marikovsky, 1956;

--- - new borders after finds of 1988;

• - concentrating places known previously;

o - concentrating places found in 1986-1990.

karakurt, and as a result, people are less careful. Despite our warning of danger in the Aktybinsk area, there have been many people and cattle bitten in 1989.

In the figure 1, the northern borders pass beyond the territory of Kazakhstan. Dotted border of karakurt North-East of Kazakhstan is established by us. Carrying out large-scale expeditions over the desert zone of Kazakhstan during the last 5 years, we have found the new karakurt concentrations designated by white circles in the figure 1. Concentrating places found by MARIKOVSKY (1956), are designated by black circles. It is important to know, that concentrations that were established by us have been constant since 1986 up to now. At the same time, we have become witness of the disappearance of at least one considerable concentration West of Alma-Ata, in Otar steppe, after the karakurt depression in 1985 caused by the late frosts when the temperature over the whole South-Eastern Kazakhstan had fallen in May to $-12-18^{\circ}\text{C}$: this led to the freezing of karakurt spiderlings (TARABAEV 1990). As a result, karakurt now occur only sporadically in the Otar steppe. At the same time, in the north-eastern part of karakurt's area we found two rather dense populations. However, these populations could have existed previously but nobody had discovered them before us.

4. CONCLUSION

On the base of views stated above one can make a conclusion about the necessity of a serious organization of the registration of damage cases caused by karakurt on people and cattle. The existence of reservations, i.e. the stabile place of extreme abundance makes it necessary to register them within the karakurt range and to carry out monitoring observations.

When organizing the registration of victims of karakurt (people and cattle), special instruction by health service specialist is required, especially in areas of high karakurt abundance.

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***Pardosa nigristernis* Denis, 1966. A North African component of the Italian and Spanish arachnofauna**

par
Paolo Tongiorgi & Carla Sola

1. INTRODUCTION

A revision of the Italian Wolf Spiders of the genus *Pardosa* by TONGIORGI (1966) had assigned, with reserve, three female specimens of a species collected in Sardinia to *Pardosa naevia* (L. Ikkock, 1875). The finding of one male and several female specimens together (June 24, 1987) and the recent revision of the *Pardosa naevia* group by M. ALDERWEIRELDT and R. JOCQUÉ (1990) prompted a revision of the previous assignment; thus, our specimens are now more correctly assigned to the closely related *Pardosa naevia* Denis, 1966 (figure 1). The new identification was carried out by comparing our specimens with *P. nigristernis* from Baniou, Algeria (R. BOSMANS, leg. 13.V.1988, ALDERWEIRELDT & JOCQUÉ, det. 1990).

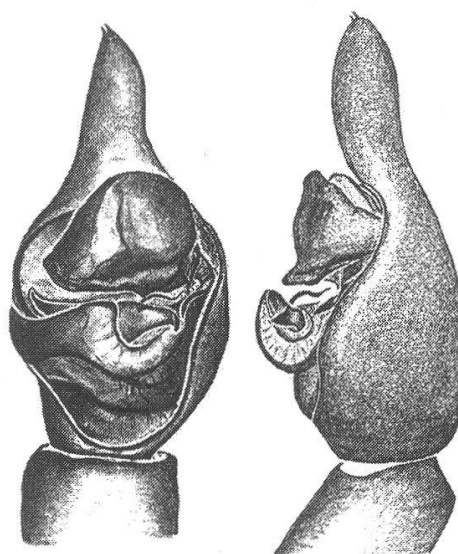


Fig. 1 - *Pardosa nigristernis*.
Left palp of a specimen from
Piscina Rey (Cagliari), Sardinia.

2. DISTRIBUTION

In Sardinia, *P. nigristernis* was found in salt marshes near Oristano and on the edge of a brackish pond at Piscina Rey (Cagliari) (figure 2). At the latter site, together with *P. nigristernis*, numerous specimens of *Pardosa proxima*, *Arctosa variana*, *A. leopardus* and *Pirata piraticus* were present. A female of *P. nigristernis* was also collected by A. Senglet in Spain, on June 16, 1971, along the shore of the La Albufera coastal lagoon, south of Valencia. *P. nigristernis* is apparently widely distributed in northern Africa, its areal ranging from Libya to Morocco, through Tunisia and Algeria. It is worth noting that the type locality (Tràghen) is a mountaneous region of the central Fezzân, a habitat quite different from the salty coastal environments inhabited by our specimens.

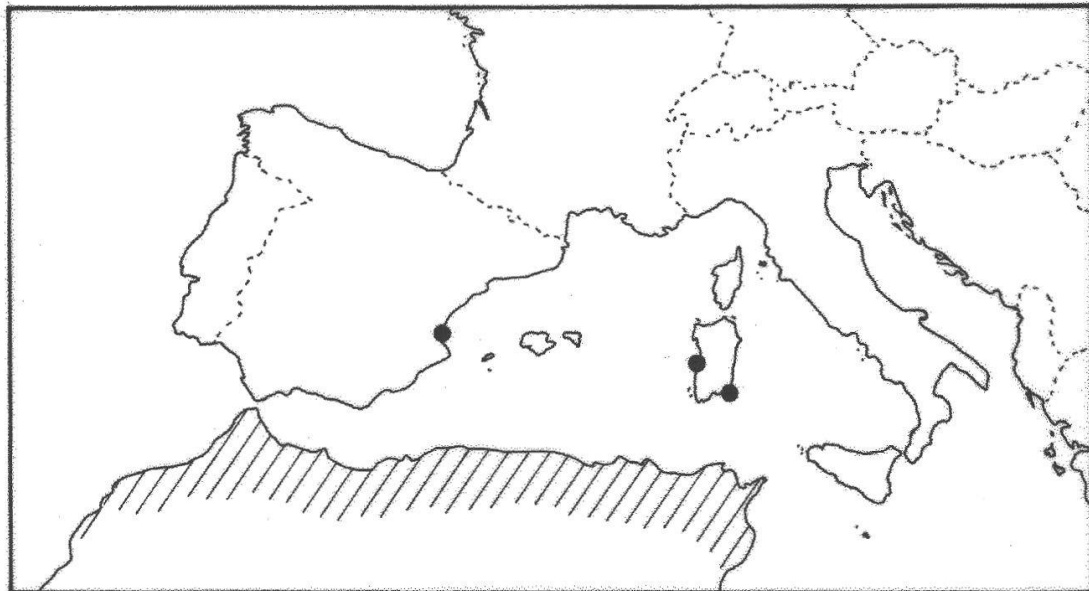


Fig. 2 - Location of the collecting station, indicated by black dots. The dashed area roughly indicates the presence of the species in North Africa.

3. BIOGEOGRAPHY

Though much controversy remains over the details, the geological history of the western Mediterranean is today fairly well understood. About 35 millions years ago the African and European land masses collided. The connection between Africa and Iberia through the Rif arc seems to have reached its maximum in the middle Miocene. Probably during this period elements of the African fauna, among these *P. nigristernis*, pushed northward, colonizing what at that time was the eastern edge of the Iberian Peninsula. Indeed, the present Sardo-Corsican Complex, Calabro- Peloritan Complex, both Greater and Lesser Kabylia, the Rif, the Betic Cordillera and Balearic Complex all

originally lied in strict contiguity. Between the late Oligocene and early Miocene (28 m.y.), forces exerted by the African continent broke off the eastern margin of the Iberian Peninsula, which subsequently fragmented into a series of microplates (between 28 and 13 m. y.) which began to migrate towards North Africa (The Kabylas) and Italy (Corsica, Sardinia, Calabro-Peloritan). The Rif separated from the Betic Cordillera and merged with Morocco. A part of the *P. nigristernis* population was probably transported along with the microplates in their east, south-east migration whereas the other remained on the eastern margin of the Iberian Peninsula. These tectonic events provide a fairly good explanation of the fragmented distribution of the species we now observe. A similar story may also be hypothesized for *Pardosa occidentalis*, a species with French-Iberian-Sardinian geonemy (TONGIORGI 1966; LEDOUX 1973).

We do not know whether it was actually *P. nigristernis* which arrived in Spain from Africa or another species of the *P. naevia* group from which *P. nigristernis* then evolved. In the second case, the current distribution of *P. nigristernis* in northwestern Africa (Maghreb, Morocco, Tunisia, Algeria, Lybia) would have been established subsequent to the collision of the African continent and the microplates from which the Greater and Lesser Kabylas and the Rif Massif in Morocco originated (early Messinian, about 6 m. y.). Anyhow, it is today soundly proved that the most typical faunistic elements of Maghreb derive from that part of Tyrrhenid which broke off from Europe during the Miocene.

Less likely could have been a diffusion of *P. nigristernis* along the coasts of the Mediterranean basin during the Messinian saline crisis (6.7-5.2 m. y.), when the Mediterranean Sea dried out almost completely and a thermophilous fauna penetrated the Mediterranean area. In this case the species would have had an ample opportunity for displacement and should have colonized new coastal salty environments besides those of eastern Spain and Sardinia. Accordingly, notwithstanding the transitional nature of these environments, evidence of a wider distribution of *P. nigristernis* should be observed, as for *Pardosa luctinosa* (TONGIORGI 1964). Instead, investigations along the Italian coasts never revealed *P. nigristernis*. The presence of this species in Sicily, where it may have arrived along with the Calabro-Peloritan plate, has not yet been investigated, but it should not be excluded a priori. Unfortunately, the coastal salty environments inhabited by this species are very scarce in Sicily. In the Pliocene, the opening of the Strait of Gibraltar again flooded the Mediterranean basin and definitively severed all connections between North Africa and southern Europe.

4. CONCLUSIONS

Arachnological research, in particular on the Lycosidae, has only given a marginal contribution to the biogeography of the Mediterranean basin. In this regard, *P. nigristernis* together with few other species of lycosids, represents a useful element to understand the processes leading to the establishment of present day western Mediterranean arachnological fauna. However, coastal areas all over the Mediterranean are highly endangered by housing and turist developments and by land reclamation for agriculture. Together with these environments, species of biogeographic interest, such as *P. nigristernis*, also risk extinction or a severe reduction of their areal. Only the creation of well managed and protected coastal areas can assure the conservation of these environments and their interesting fauna.

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Sperm Storage and Repeated Egg Production in Female *Pholcus phalangioides* Fuesslin (Araneae)

par
Gabriele Uhl

Summary: 35 Female Daddy-long-legs spiders were allowed to copulate only once. Each individual female was kept separately for up to 375 days after copulation. Mating took place after an average of 8 days after the moult to adulthood. Egg-sac production of 35 females was recorded. Hatching success of the spiderlings was recorded for the egg batches of 32 females.

All except one female produced at least one egg-sac. Some produced up to 6 batches of eggs during the registration period. The hatching success of the spiderlings was high even after repeated egg-sac production.

Ph.phalangioides does not possess any concrete sperm storage organs such as receptacula. Sperm is stored in the genital cavity (uterus externus), embedded in glandular secretions discharged from two gland structures situated in the posterior part of the uterus externus. Nevertheless, the sperm mass does not get flushed out with one egg-laying process, which would call for repeated insemination. On the contrary, females of *Ph.phalangioides* are able to produce more than one fertilized batch of eggs, despite of their "primitive" bursal storage mode.

1. INTRODUCTION

P*holcus phalangioides* is quite abundant in houses and cellars. Sheltered from extreme climate, reproduction is not restricted to the warmer seasons. Therefore, Daddy-long-legs spiders are easy to work with in respect of reproductive behaviour. Female spiders store sperm in receptacula seminis for prolonged periods of time. Sperms are transmitted and stored in an encysted state i.e. encoiled and surrounded by

a secretory envelope (ALBERTI 1990). In *Ph.phalangioides*, like in other so-called haplogyne spiders, the sperm might get stored in the genital cavity (uterus externus or bursa copulatrix) (WIEHLE 1967, KOVOOR 1981). If this was true, the sperm mass would be easily flushed out with the passage of each batch of eggs and repeated mating would inevitably be necessary (FORSTER 1980). The reproductive behaviour of *Ph. phalangioides* was examined to find out how many egg-sacs a female is able to fertilize with the sperm of one single mating. The results help to estimate the actual constraints being imposed on such a haplogyne structure.

2. MATERIAL AND METHODS

Juvenile individuals of *Ph.phalangioides* were collected from the Zoological Department and from homes around Freiburg i.Br.. They were kept individually in plastic boxes of 10x10x7 cm (LxWxH). After the moult to adulthood the spiders were kept in couples in slightly bigger boxes (17x9x6,5 cm). During the day, male and female had access to each other. They were checked at least every 30 minutes. At night, the male was kept separately from the female partner, being enclosed in a plastic vessel within the plastic box. The couples were allowed to copulate only once. After copulation the females were kept separately in the smaller rearing boxes for up to 375 days.

Egg-sac production and the emergence of first-instar nymphs were recorded and the hatching success was determined as the number of spiderlings which emerged from an egg-sac in relation to the total number of eggs laid.

The rearing room was maintained at 23 to 28°C under constant photoperiod (14L-10D). The spiders were provided one fly (*Musca domestica* or *Lucilia spec.*) every 7 days.

3. RESULTS

From final moult to mating adult individuals took 8.3 days on average ($n=35$, $sd=3,3$) (figure 2). After one single copulation, 32 of 35 females produced more than one batch of eggs (91%) (figure 1). 54% made 3 or 4 egg-sacs. 4 spiders produced 6 egg batches. The results do not indicate the highest possible number of egg-sacs produced by one female. Rather, the data relate to the egg-sac production achieved during the registration period.

The time intervals from the production of one egg-sac to another varied greatly within a single individual and in comparison with other individuals (figure 2). Figure 2 shows that in a similar time period some individuals produced up to two egg batches more than others (e.g. no.24 compared with no.31).

The spiderlings hatch 16,7 days on average after egg laying ($n=30$, $sd=2,8$). The female enhances the hatching by eliminating the silken threads that hold the eggs together. The number of eggs in each egg-sac and the number of spiderlings that hatched from

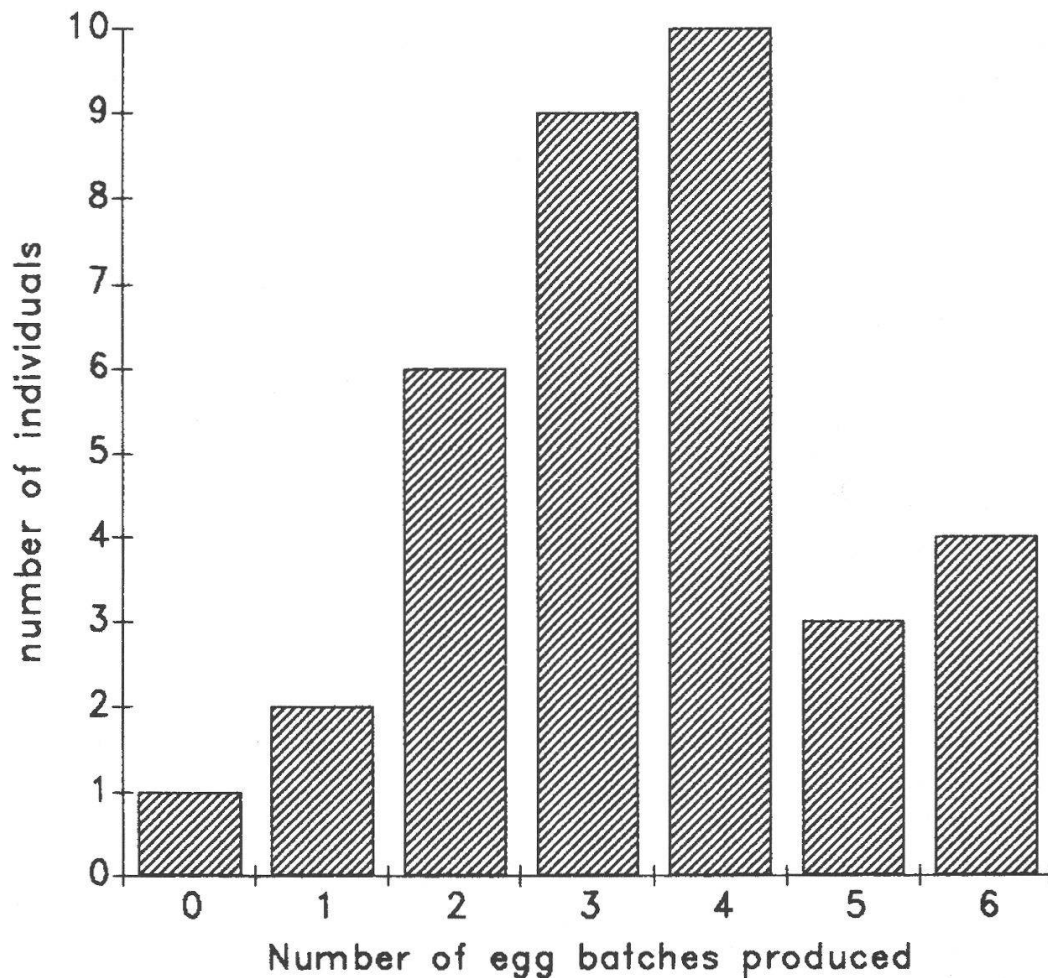


Fig. 1 - Egg-sac production by 35 females of *Pholcus phalangioides* during the registration period.

the egg-sacs are shown in figure 3. The hatching success differs greatly from egg batch to egg batch. Females which did not succeed in producing fertile eggs for example in the first egg batch, were mostly able to produce a high percentage of viable offspring in the following egg-sacs, some with up to 100% hatching success. Even after repeated egg-sac production the hatching success could be very high. Some females stored viable sperm up to one year.

In *Ph. phalangioides*, sperm is stored in the genital cavity, in the so-called uterus externus. In order to hold the sperm in a fixed position, a glandular secretion is discharged from two complex gland structures situated in the posterior part of the uterus externus (these results will be published elsewhere in detail). The entire filling of the genital cavity coincides with the onset of the mating behaviour. Semithin sections of the genital cavity show that the secretory product is built up in the course of about 8 days after the final moult.

Females are able to fertilize more than one batch of eggs although after oviposition only a few clumps of sperm are left in the genital cavity, mostly close to the heavily sclerotized valve or the glandular pores. The remaining sperms are encoiled and nonflagellate.

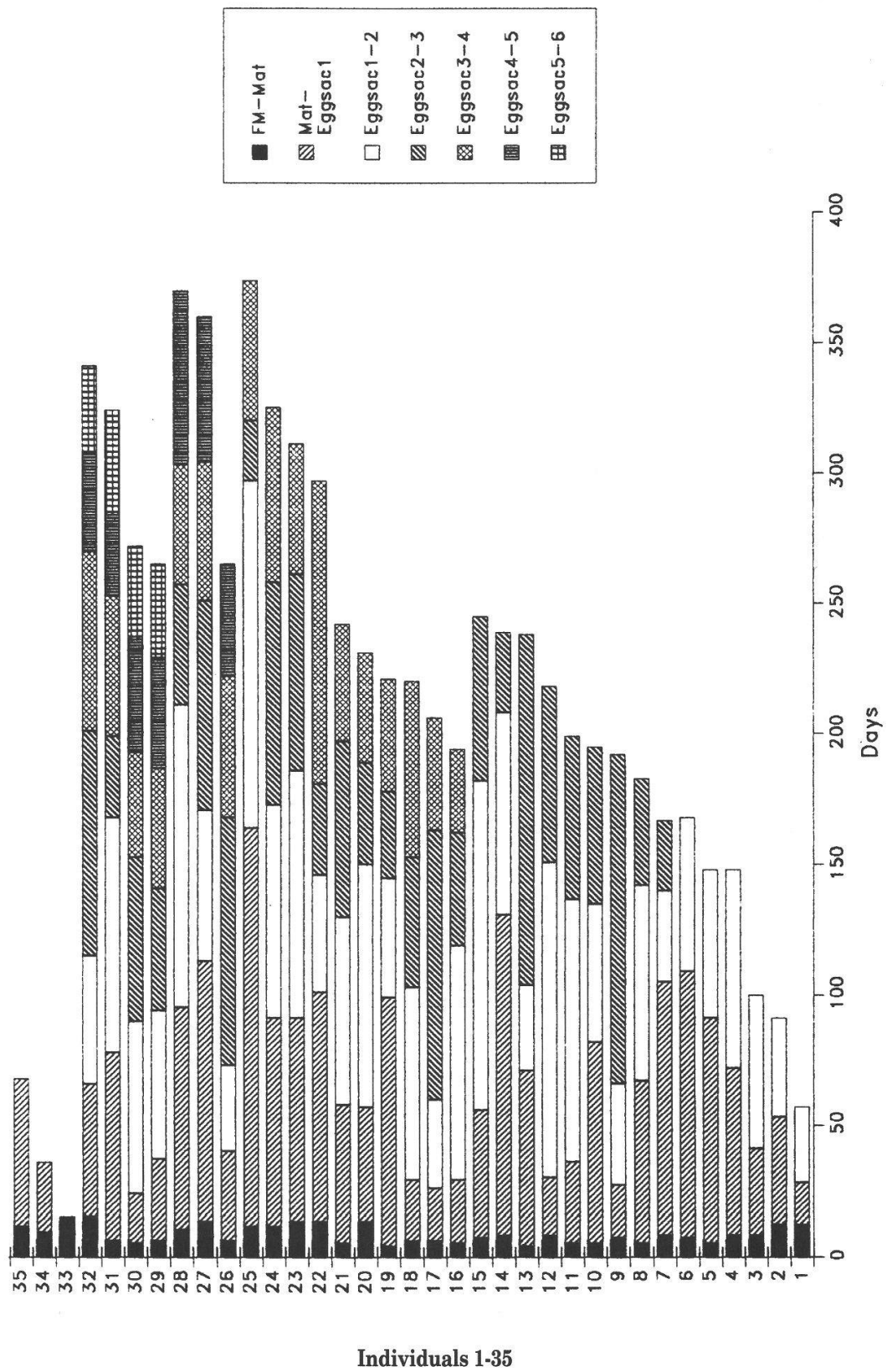


Fig. 2 - Periods of time elapsed between the final moult and mating (FM-Mat) and between one egg laying and the following egg laying of *Pholcus phalangioides*. The individual reproductive history is given for 35 females, whose numbers correspond with those given in fig.3.

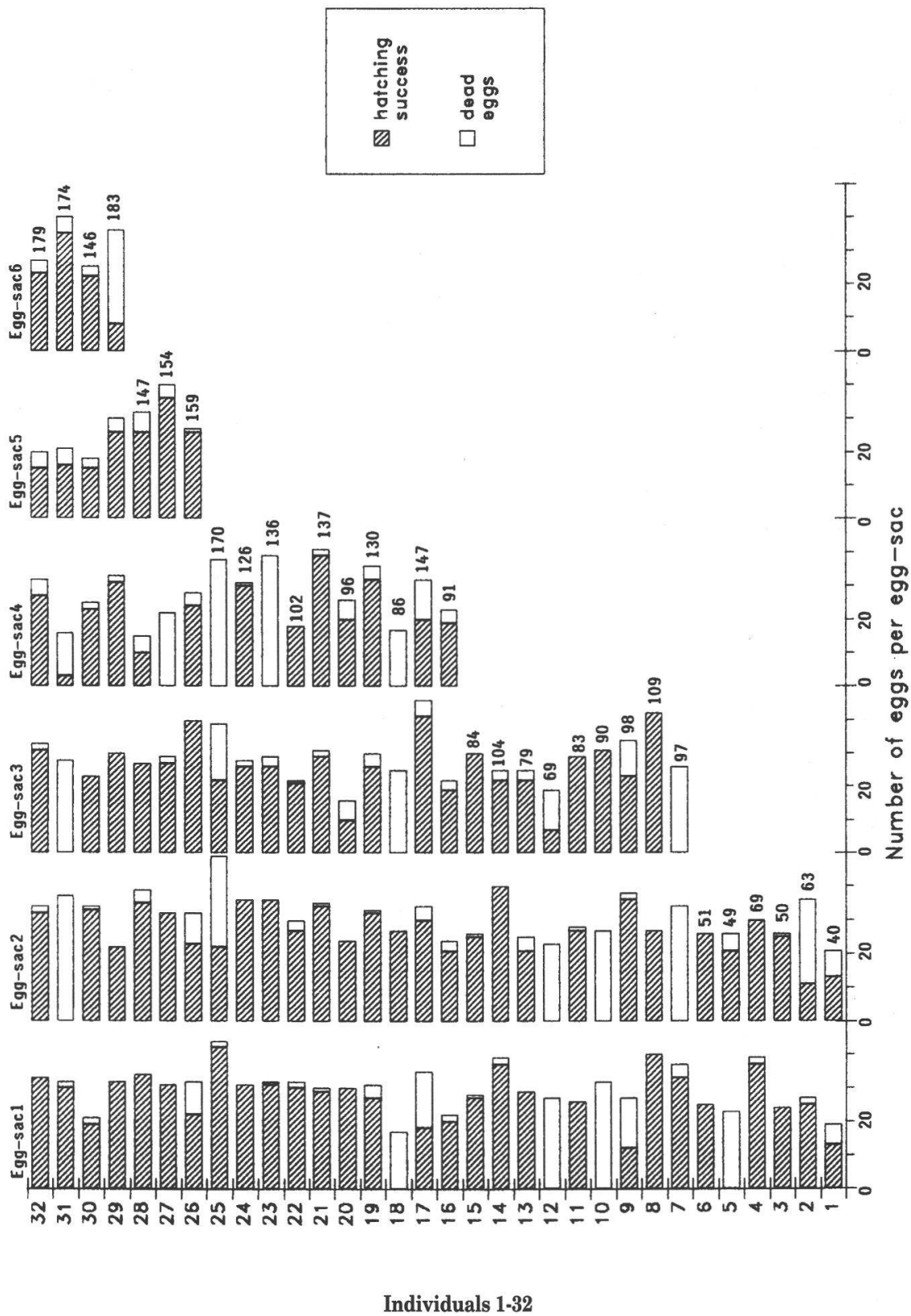


Fig. 3 - The reproductive success of 32 females of *Pholcus phalangioides*. The amount of eggs laid per batch and the number of spiderlings that hatched from each batch of eggs are given. The figures at the end of the bars represent the total number of eggs laid by the individual female during the registration period.

4. DISCUSSION

Female Daddy-long-legs spiders copulate about eight days after their final moult. Apparently, this is the time required for the glandular cells of the uterus externus to mature and to fill the genital cavity with glandular secretions. If the female would not provide a matrix for the sperm to be stored in, the sperm could possibly get lost through the genital opening. Therefore, I consider the prime function of the secretion in fixing the sperm mass in a specific position. This phenomenon is also known from various Coleoptera. Females of *Speonomis delarouzei* (Catopidae) mate only 24-32 days after the moult to adulthood, as the spermathecal accessory glands take this long to develop and to discharge their products into the pouch of the spermatheca (JUBERTHIE-JUPEAU & CAZALS 1985). Also, in mealworm beetles (*Tenebrio molitor*) a high percentage of females copulate only after the spermatheca is fully filled with secretory products, which takes four days to accomplish (HAPP & HAPP 1970). Another beetle, *Aleochara curtula* (Staphylinidae), is known to possess spermatheca filled with secretions when willing to mate (GACK, pers.comm.). The coincidence of receptivity and filled spermatheca probably is a general phenomenon in arthropods that has not yet been paid attention to.

The time intervals from one egg-laying to another were irregular, which is possibly due to the rearing conditions (temperature differed greatly). However, the results of MIYASHITA (1988) show that despite of constant rearing conditions cocoon production was irregular. He stated a tendency of increasingly prolonged time spans between ovipositions the more egg batches are produced, which I cannot confirm.

Repeated egg laying itself is not a guarantee for successful reproduction, as many female spiders are known to lay eggs although they never had mated. The case of *Ph.phalangioides* shows that even after repeated egg-sac production the amount of viable offspring can be very high. This is surprising, as the females of *Ph.phalangioides* store the sperm mass in the genital cavity where it is liable to be washed out during oviposition. In fact, only a small amount of sperm seems to be left in the genital cavity, but obviously sufficient to fertilize following egg batches. The remaining sperms are encoiled like the encysted sperm that get transferred in a copulation. From this follows that these sperms are either infertile and not able to capacitate, or that subsequent to oviposition the sperm recoil. The recoiled state might represent a period of reduced energy expenditure, which could increase sperm longevity. In 1985, BROWN demonstrated, that in *Nephila clavipes* the sperm become nonflagellate following oviposition. It is likely that the sperm cells that capacitated prior to oviposition and did not have the chance to fertilize one of the eggs recoil to outlast until the following egg laying. The results show that sperms are able to survive within the secretory substance up to a year (figure 2) and possibly even longer. Therefore, female Daddy-long-legs spiders are not depending on repeated matings to bring forth more than one batch of eggs. FORSTER (1980) developed a hypothetical evolutionary pathway from the "primitive" storage mode where the sperm mass is transferred into and retained within the uterus

externus (bursa copulatrix), to the development of receptacula where the sperm is stored away from the genital tract. FORSTER assumes that the "bursal storage mode" has little survival value. He considers the development of receptacula to be of immense advantage as this would eliminate the need for repeated insemination and would offer the possibility to economise on the sperm of a single copulation in order to fertilize as many egg batches as possible. Nevertheless, females of *Ph.phalangioides* are able to produce several egg-sacs after a single mating. The claimed negative effect of the bursal storage mode is not that clearcut, but very likely a small percentage of improved reproductive success has been sufficient to stimulate the development of spatially separated storage structures.

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Can *Macrothele calpeiana* (Walckenaer) (Araneae, Hexathelidae) be used as a bio - indicator ?

par
Peter J. van Helsdingen

In 1987 *Macrothele calpeiana* became a Bern Convention species. The full name of the Bern Convention is the Convention on the Conservation of European Wildlife and Natural Habitats. The Convention itself has a juridical structure and there are no names of species in it. The species are listed separately in Appendices. *Macrothele calpeiana* figures in Appendix II, the "Strictly protected fauna species". The vital core of the Convention, particularly in relation to invertebrates, is article 4, which deals with the protection of habitats.

The Bern Convention functions on the European level. It is a product of the Council of Europe and the member states, after ratifying, have to care for implementing it in their respective countries. The species in the appendices are selected, among others on their status of being vulnerable or endangered. The final decision on the composition of the appendices has all the characteristics of political play. Proposals are put forward by the permanent secretariat, taken home by the delegations and discussed at the relevant ministerial levels in each member state and subsequently are accepted or turned down at the next meeting.

As usual the Bern Convention started with birds and mammals, of which animal groups the knowledge is more generally available. Many countries already had bird or game acts and the decline and sometimes near - extinction of many of these larger vertebrates was even known to the general public. In 1987 for the first time invertebrates were included. A list of 78 species was proposed for inclusion in the appendices by the IUCN Conservation Monitoring Centre at Cambridge (UK) and, with a few modifications, was adopted. Butterflies and molluscs dominate, and there are beetles and dragonflies, and

one spider, *Macrothele calpeiana*. It is not surprising that butterflies score high among the invertebrates added: among the insects butterflies are popular with entomologists and attractive to everybody. Their decline has been noticed and is seen as a sign of the deterioration of nature. In 1989 the European Invertebrate Survey (E.I.S., E.E.W., C.I.E.) became involved with the invertebrate part of the Bern Convention. The Bern Convention Committee agreed that the inclusion of an invertebrate species in the appendices should be based on sound knowledge of its distribution and ecology, just as with the vertebrates. The E.I.S. because of its international network of invertebrate taxonomists and ecologists and their data - bases ("data - banks") was decided to be the appropriate body to bring together as much information as possible over the complete geographical range of a species and provide the required sound basis for its inclusion in the Bern Convention appendices. It also has become the task of the E.I.S. - members in the so - called Group of Experts at Strasbourg to propose new candidates for the appendices and request removal of old ones when their inclusion proves to be wrong. There is, of course, only one way to handle the matter properly: start with collecting available data from the literature, from taxonomists and ecologists, for any possible candidate suggested by anybody. With the aid of the thus accumulated information one then can decide whether the species should be included in the appendix of the Bern Convention or not. It is of no use, indeed it has strongly negative effects, if a species is placed on the appendix on incomplete and insufficient information and is found out afterwards that its position there is disturbing and untenable. Such actions undermine the credibility of nature conservation. The arguments for selecting a species are found by testing against a set of criteria and the terms of reference for the Group of Experts even allow of adapting the set of criteria to one suitable for dealing with invertebrates. The life conditions are often much more complex for invertebrates than for vertebrates and the term habitat is often less easily defined for e.g. insects that depend on aquatic habitats in their early stages but use drier habitats for their further development.

As indicated above, the Bern Convention concentrates on animals that are endangered or vulnerable. These are not biological criteria, but the deplorable result of human interference with nature. The obligation to protect the habitats of the included species lifts the convention above the level of mere species protection. If we could put bio - indicators on the list, which are characteristic for a certain type of habitat, the protection of the habitat would be the goal and the species the medium to reach that goal. SPEIGHT (1986) already listed a number of criteria for the selection of species to be used as bioindicators.

In fact this has been more or less the reason for including the spider *Macrothele calpeiana* in the appendices of the Bern Convention. SNAZELL (1986) published a three - page note on this large spider known to occur in the southern tip of Spain, where it had been recorded from a few localities only. SNAZELL now found the species on many sites in a more extensive area and put forward a hypothesis that the occurrence of the spider

was correlated with the area of high rainfall in the South. Moreover, SNAZELL stated the species to have as its optimum habitat undisturbed Cork oak woodland (*Quercus suber* L.) which according to him is under threat of exploitation of the woods and the spread of housing developments, although he sees no immediate danger. Still the Conservation Monitoring Centre picked up the message and included *Macrothele calpeiana* in their list of endangered invertebrate species (COLLINS & WELLS 1987). It is treated as a bio - indicator for Cork oak woodland and the creation is suggested of special protected sites where this species is common.

As indicated above, entering a species in a Bern Convention appendix should be based on sound knowledge about its distribution in present and past and its ecological requirements. SNAZELL (1986) publication contains a distribution map which indeed shows many more sites than the few published with the original description and in subsequent decades. He does not specify his localities and only summarizes his ecological data. About at the same time, but unobserved by COLLINS & WELLS (1987), another publication on *Macrothele* appeared (BLASCO & FERRANDEZ 1986). This distribution map already shows a more extensive range if compared with that of SNAZELL (1986), with unexpected records from Huelva, much to the North, and North Africa (Spanish Morocco), the latter supporting an earlier record from North Africa (Algeria) by LUCAS (1846). All localities are listed with UTM-coordinates for 10 x 10 km squares. Nothing is said about the habitats of the different sites. Finally SNAZELL & ALLISON (1989) recapitulate their own 1986 results and those of BLASCO & FERRANDEZ (1986), bringing together all the localities on one map and specifying some of their own with UTM-coordinates at a 1 x 1 km square accuracy. They elaborate on the ecology (vegetation and rainfall) and discuss their ecological and biological findings. Recently further progress has been made through our own research (VAN HELSDINGEN & DECAE in press) and the following overall picture is derived from both literature sources and our own data.

The interpretation of the distributional data from the recent articles proved to be difficult. While BLASCO & FERRANDEZ (1986) presented grid - references for all localities at 10 km accuracy these are sometimes difficult to correlate with the small and rather schematized map. SNAZELL & ALLISON are much more accurate with their one km accuracy, but their map is at a completely different scale and without any grid, leaving one but to guess about the exact positions of the unlisted localities. Also some of BLASCO & FERRANDEZ' localities were not included. If an author publishes fresh data in such a way that they cannot be reproduced easily by subsequent users their scientific value is severely diminished.

In order to obtain a practical distribution map we decided to transform all distributional data to a 5 x 5 km UTM-grid, our own (1 km accuracy) as well as those from the

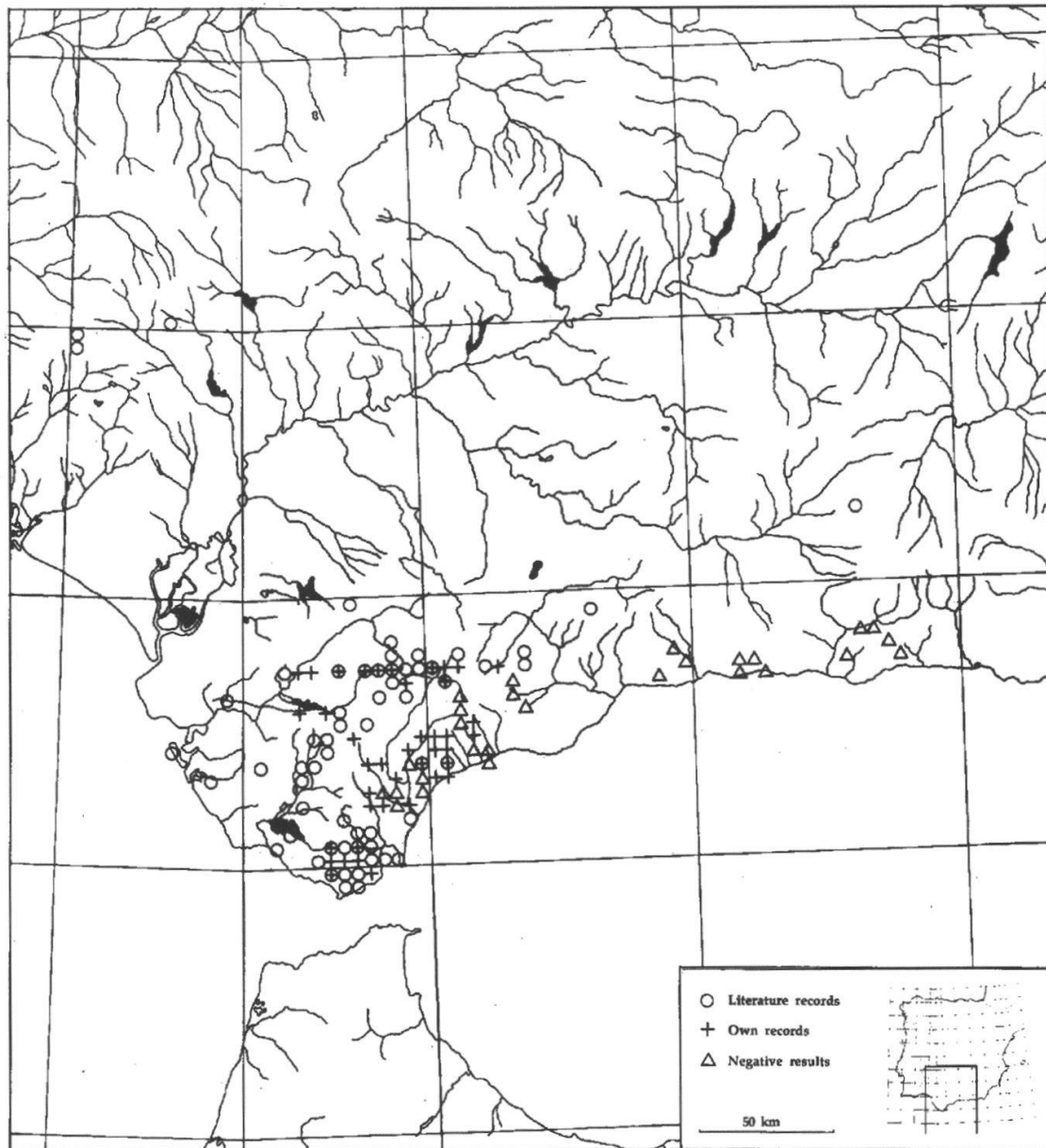


Fig. 1. - Provisional distribution - map of *Macrothele calpeiana* in Spain and North Africa (Algeria not included) using 5 x 5 km UTM - grid.

literature (fig. 1). This allows new records to be put in very easily. We have also marked the localities where *M. calpeiana* was not found, though this negative result, of course, refers to the sites visited only and not to the whole 5 x 5 km area, just as a positive symbol refers to a site or sites within the 5 x 5 km square and does not mean a complete coverage of the whole square. A 5 km accuracy suffices to indicate the distribution of a species in an area of at least 300 x 250 km.

We have added quite a number of localities in the very south in the Tarifa - Algeciras region and in the region around Estepona, as well as in the Ronda - Grazalema - Arcos de la Frontera belt. Many others were confirmed. Most sites lie within the zone of an

annual precipitation of 80 - 100 cm, as do most of the records from the literature. The coastal area from Malaga to slightly east of Motril appeared to be devoid of *Macrothele*. Thus the core of the distribution area remains as indicated by the earlier authors: between the city of Cadiz and Malaga and south of the line Jerez - Antequera. The outer boundaries of the whole distribution area of the species, however, are far from established. If one realizes that within the last decade the species has been found north of the Guadalquivir in the province of Huelva (on three localities), in the Sierra Harana, north of Granada (one locality, leg. BARBARA Y. MAIN) and in Spanish Morocco (one locality, BLASCO & FERRANDEZ 1986) one may expect quite a number of new discoveries and an extension of the known range. It is, therefore, much too early to talk about a vulnerable or endangered species. We need further inventories first leading to a more or less "complete" distribution map. The new records do indeed come from areas with high precipitation and SNAZELL hypothesis should be tested further, also for other regions with comparable rainfall but without any records yet.

During our fieldtrips we have come to conclusions that differ to a large extent from those of SNAZELL & ALLISON (1989). *Macrothele calpeiana* is common on suitable sites, where shade is offered and hiding conditions are available, such as cracks or holes in the soil, boulders or logs of wood. Bare, open soil with full exposure to sun, and maybe wind and rain, are shunned. Cork oak forest or mixed forest, if the spider occurs there, harbours low density populations. Olive and Eucalyptus cultures score higher as do road - sides, rubbish dumps, picnic places and city walls. Cultivated oakland scores higher than undisturbed forest. So far the Guadalquivir valley with its lowland farmland appears empty space as far as *Macrothele calpeiana* is concerned. It is largely unforested and has a low precipitation, but there may be other limiting factors involved. One gets the impression that the species, in suitable habitats, benefits from mild human interference and when conditions become extreme is able to hold its own, e.g. by becoming arboreal. We may call it an aggressive species, in the ecological sense, which favours dynamic situations. We also may pose the question whether the recent extension of the known geographic range is the result of more intensive fieldwork or due to active spreading of the species in recent times.

M. calpeiana is certainly not endangered. Neither is it a bio-indicator for Cork oak woodland. A bio - indicator for a certain habitat has a strong and often obligatory relationship with that particular habitat. The species becomes less abundant when the habitat deteriorates and gradually disappears when the habitat degenerates, or at least loses its particular character. It therefore can be used as a numerical parameter for the quality of the habitat. We have found that *M. calpeiana* has no obligatory relationship with Cork oak woodland as a natural habitat.

We conclude that *M. calpeiana* has been placed too quickly and without sufficient knowledge of its basic ecology in an appendix of the Bern Convention, where it serves no practical purpose.

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Remarques sur la répartition des araignées dans un marais de plaine

par
Olivier Villepoux

Résumé: Le peuplement d'araignées du marais de Lavours (plaine alluviale du Rhône) a été étudié en 1989 par l'application de divers modes de capture dans les différents groupements végétaux hygrophiles présents. L'analyse de ces résultats, ainsi que leur comparaison avec des prélèvements réalisés trois ans auparavant, permettent de dégager certaines tendances dans l'évolution de la faune du marais. L'exemple cité porte sur trois milieux: la cladiaie, la cariçaie mésotrophe et la phragmitaie. D'importantes modifications dans les peuplements de ces biotopes sont constatées et on en analyse les causes possibles. L'instabilité du site, due à des inondations, semble jouer un rôle prépondérant. Un second exemple met en évidence quelques caractéristiques dans la répartition fine de certaines espèces ou groupes d'espèces en fonction de microhabitats particuliers présents dans la cladiaie. Des conclusions quant à l'utilisation des araignées en tant que bioindicateurs en sont tirées.

1. INTRODUCTION

La réserve naturelle du Marais de Lavours a été créée en 1984. Elle est située au nord du lac du Bourget, dans la plaine alluviale du Rhône, entre la terminaison méridionale du Jura et les chaînes subalpines. Ce vaste ensemble de milieux humides s'organise en séries hygrophiles et mésophiles autour d'une large zone axiale de tourbières alcalines.

Dans le cadre de l'inventaire et de la gestion de cette réserve naturelle, nous avons effectué la première étude des araignées de Lavours en 1986. Après quelques compléments en 1987, une seconde étude plus approfondie a été réalisée en 1989.

L'exploitation de ces données est encore en cours, toutefois deux aspects du peuplement aranéologique du Marais, qui illustrent des problèmes ayant trait à l'utilisation des araignées en bioindication, peuvent déjà être relatés.

2. SITE D'ETUDE ET METHODES

La partie principale de la réserve du Marais de Lavours s'étend sur 424 ha de terrains tourbeux ou limoneux. De vastes surfaces de cladiaies tourbeuses (à *Cladium mariscus* et *Schoenus nigricans*) sont entourées de cariçaies sur tourbe et limon (à *Carex elata* et *Molinia coerulea*) puis de phragmitaies à carex (*Phragmites australis* dominant) sur sol encore plus limoneux. Des cariçaies eutrophes à hautes herbes ainsi que des groupements forestiers hygrophiles (aulnaies) ou mésophiles (chênaie-frênaie), en situation généralement plus périphérique, complètent la réserve (AIN et PAUTOU 1969).

Seules les parties les plus centrales du Marais (de la cladiaie à la phragmitaie) ont été étudiées en 1986 par des piégeages systématiques donnant des résultats quantitatifs (pièges "Barber" et pièges à émergences). En 1989, tous les types de milieux ont été échantillonnés à l'aide de pièges "Barber" et d'assiettes colorées. Plusieurs milieux ont également accueilli des pièges à émergences. Par ailleurs, de nombreuses captures par chasse à vue, battage de branches et tiges de phragmites, fauchage au filet ont été réalisées au cours de ces deux périodes.

3. TENDANCES ECOLOGIQUES ET MICROHABITATS DANS LA CLADIAIE

Les différentes méthodes d'investigation mises en oeuvre de 1986 à 1989 ont permis de bien connaître la faune des araignées de la cladiaie. Ce groupement végétal typique des tourbières alcalines de plaine se développe dans les zones où la nappe phréatique affleure la surface du sol pendant pratiquement toute l'année. Par ailleurs, cette cladiaie correspond à une végétation de type herbacée, la plupart du temps sans arbustes, et subit, de par sa localisation géographique, une forte insolation durant une bonne partie de l'année, induisant un apport thermique notable pendant la belle saison. De telles caractéristiques écologiques faisaient prévoir, pour ce milieu particulier, une faune aranéologique présentant, à côté des espèces ubiquistes, une composante hygrophile-photophile largement dominante et l'absence d'araignées sténoèces pour les tendances opposées.

Or, 80 espèces vivent dans la cladiaie, et parmi celles dont les exigences écologiques sont assez strictes, trois groupes distincts apparaissent (Planche I). On trouve, bien évidemment les espèces hygrophiles-photophiles attendues, comme *Evarcha arcuata* ou

Espèces Hygrophiles Sciaphiles	Espèces Hygrophiles Photophiles	Espèces Héliophiles Thermo-Xérophiles
<i>Pirata hygrophilus</i> <i>Hygrolycosa rubrofasciata</i> <i>Zelotes lutetianus</i> <i>Diaea dorsata</i> <i>Agracina striata</i> <i>Gongylidiellum murcidum</i>	<i>Pirata latitans</i> <i>Oxyptila simplex</i> <i>Evarcha arcuata</i> <i>Marpissa pomatia</i> <i>Clubiona phragmitis</i> <i>Antistea elegans</i>	<i>Poecilochroa variana</i> <i>Thomisus onustus</i> <i>Mithion canestrinii</i> <i>Phlegra fasciata</i> <i>Trachelas minor</i> <i>Phrurolithus festivus</i>

Pl. I - Principales tendances écologiques dans le peuplement de la cladiaie (les espèces sont citées pour exemple)

Oxyptila simplex, mais, à leur côté, existent deux catégories d'espèces dont les préférences semblent en contradiction avec les caractéristiques du milieu. Il s'agit d'un ensemble d'espèces hygrophiles-sciaphiles, comme *Pirata hygrophilus* ou *Diaea dorsata*, et d'un ensemble que l'on peut qualifier d'héliophiles thermo-xérophiles, dont *Mithion canestrinii* ou *Thomisus onustus* sont des exemples. A première vue, il est surprenant de trouver ainsi *Pirata hygrophilus*, habituée des bois humides et que RENNERT (1986) indique préférer les "habitats with low evaporation, low temperature and low light values", en compagnie de *Poecilochroa variana* classée sténoxérophile par MAURER et HÄNGGI (1990) qui la localisent dans un "trockene, sonnenexponierte Standorte", et de *Trachelas minor* que l'on trouve "dans les endroits arides" (HUBERT 1979).

C'est en observant la structure de la végétation que l'on peut expliquer cette apparente incohérence. La plante dominante, le cladium, pousse de façon dense en formant une petite touffe constituée par les feuilles sèches des années précédentes. C'est du centre de ce "tronc" que partent les nouvelles feuilles vertes de l'année et la hampe florifère. Les feuilles sèches, abondantes, se recourbent pour s'entremêler avec celles des pieds voisins, constituant ainsi un épais feutrage suspendu à une trentaine de centimètres du sol. Cette couche, continue sur de grandes surfaces, forme à la fois un écran isolant (photique, thermique et convectif) et un support très sec, analogue à une "micro-canopée" dans cette forêt de cladium (Figure 1).

Cette structure de végétation détermine deux biotopes très distincts au sein du même milieu apparemment homogène. Le biotope inférieur est au contact direct du sol tourbeux perpétuellement imbibé d'eau; l'air y est très humide et la luminosité réduite, effet encore accentué par la noirceur du sol; la température est assez stable et reste fraîche, même l'été en plein après-midi. Au contraire, la surface supérieure de la "micro-canopée" est isolée de l'humidité du sol et reçoit, sans protection, l'influence directe du soleil; la lumière est vive et l'air y est sec, tout comme le support dont la couleur claire réverbère les radiations; la température de surface et de l'air environnant

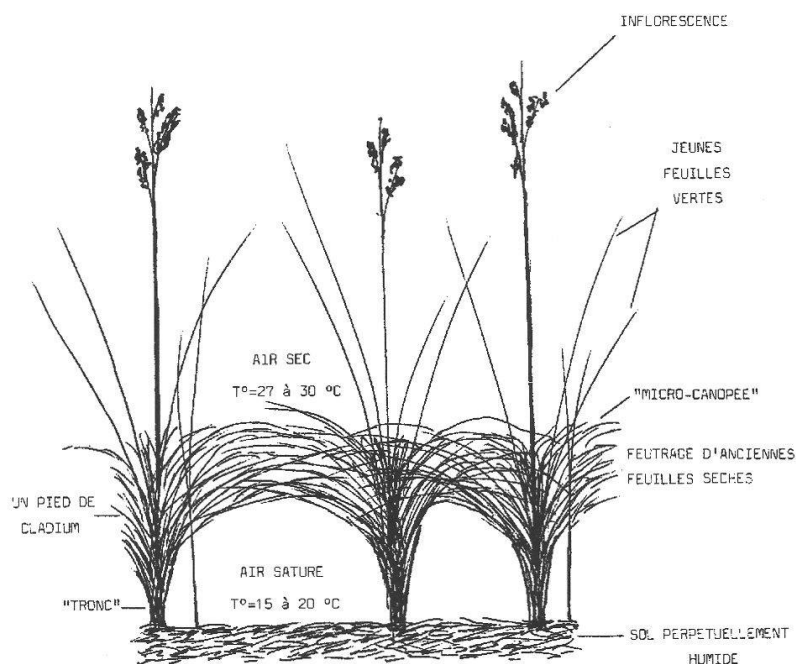


Fig. 1 - Coupe schématique dans la végétation de la cladiaie dense du Marais de Lavours.

augmente fortement au cours de la journée, pouvant dépasser de plus de 10°C celle du biotope inférieur.

Ainsi des espèces aux exigences écologiques totalement opposées peuvent coexister dans une même station par le jeu de ces microhabitats très spécifiques créés par la structure fine de la végétation. Ces exigences peuvent, de même, être fort différentes des conditions environnementales globales du milieu considéré.

4. MODIFICATION DES PEUPLEMENTS ENTRE 1986 ET 1989

L'étude, en 1986, d'une zone de phragmitaie, d'une zone de cariçaie mésotrophe et d'une zone de cladiaie (dite cladiaie nord) à l'aide de pièges "Barber", a permis d'obtenir des résultats quantitatifs sur l'abondance-activité de chaque espèce échantillonnée par cette technique. En 1989, les mêmes pièges ont été placés dans les mêmes stations. La cladiaie nord étant soumise depuis 1987 à un pâturage extensif par un petit troupeau de bovins, les pièges de cette station furent installés dans une placette (20 mètres sur 20 mètres) mise en défens et où la végétation reste intacte. De plus, une seconde cladiaie (dite cladiaie sud), située plus au sud dans la Réserve, et séparée de la première par une large étendue de milieux divers, fut également équipée de pièges identiques. Enfin la cariçaie a été fauchée en 1987, ce qui a légèrement modifié son aspect en faisant disparaître les petits arbustes qui y étaient présents en 1986.

La comparaison des résultats de 1989 avec ceux de 1986, pour les espèces aux effectifs

suffisants, montre des modifications du peuplement très importantes, tant au sein de la cladiaie que des deux autres milieux étudiés (Planche II).

Ainsi, deux espèces de *Zelotes* étaient présentes, avec des effectifs proches, en 1986 dans la cladiaie: *Z. latreillei* et *Z. lutetianus*. Elles semblaient se trouver en situation de compétition, étant des espèces voisines aux caractéristiques très similaires. Or en 1989, *Z. latreillei* a totalement disparu. Elle ne fut plus capturée nulle part dans la réserve, pas même sous forme immature. *Z. lutetianus*, par contre, présente une légère augmentation, mais peu significative, et des effectifs équivalents dans les deux cladiaies (nord et sud).

Deux autres araignées semblaient également en situation de concurrence interspécifique dans la cladiaie, de par leur extrême proximité taxonomique. Il s'agissait de *Pardosa pullata* et de *Pardosa prativaga*, toutes deux abondantes dans ce milieu en 1986. Mais, en 1989, *P. pullata* a, elle aussi, complètement disparu du site alors qu'elle dominait largement la faune épigée de la cladiaie en 1986 ! *P. prativaga* ne paraît pas avoir bénéficié des ressources laissées libres par sa "concurrente", car ses effectifs en cladiaie s'établissent (de façon identique pour les deux stations) à un niveau légèrement plus faible qu'en 1986. Par contre, on observe une très forte augmentation de ses captures dans la cariçaie et dans la phragmitaie.

D'autres espèces de lycosides de la cladiaie montrent des variations très importantes d'effectifs entre les deux années étudiées. Certaines présentent une forte augmentation, toujours très significative, à partir d'un nombre de captures très faible en 1986 dans la cladiaie: C'est le cas de l'espèce nouvelle (pour la France en tout cas) *sp1*, de *Pirata hygrophilus*, de *Pirata tenuitarsis* et d'*Hygrolycosa rubrofasciata*. Leurs effectifs dans les cladiaies nord et sud sont équivalents en 1989. Par ailleurs, les abondances de ces espèces peuvent aussi présenter des variations dans les autres biotopes, faibles comme c'est le cas pour *Pirata hygrophilus* dans la phragmitaie, ou fortes comme pour *Pirata tenuitarsis* dont l'effectif triple dans ce même milieu en 1989.

D'autres lycosides présentent, au contraire, une diminution des captures de 1986 à 1989: *Pirata latitans* est dans ce cas, ainsi que *Trochosa spinipalpis* qui toutefois affiche un effectif très élevé dans la cladiaie sud (non échantillonnée en 1986) et une forte augmentation en phragmitaie tandis qu'elle diminue dans la cariçaie toute proche.

Des changements affectent aussi d'autres familles que celle des lycosides: *Oxyptila simplex*, qui reste stable en cladiaie, augmente dans la cariçaie et surtout dans la phragmitaie ; *Antistea elegans* augmente dans la cladiaie nord de façon significative alors qu'elle est absente de la cladiaie sud.

Agraeocina striata, enfin, reste au même niveau de capture, très faible, dans les trois stations échantillonnées en 1986 et 1989 (phragmitaie, cariçaie et cladiaie nord), mais

	CLADIAIE Nord Sud		CARICAIE	PHRAGMI- TAIE	EVOLUTION
<i>Zelotes lutetianus</i>	14 6	11	3 0	0 2	= =
<i>Zelotes latreillei</i>	0 5	0	0 0	0 0	= =
<i>Pardosa pullata</i>	0 79	0	0 0	0 4	= =
<i>Pardosa prativaga</i>	18 31	24	109 18	72 20	
<i>Lycosidae sp1</i>	42 3	32	0 0	4 0	= =
<i>Pirata hygrophilus</i>	38 1	22	2 0	12 0	=
<i>Pirata tenuitarsis</i>	25 4	18	19 38	100 32	
<i>Hygrolycosa rubrofasciata</i>	12 0	11	1 4	4 4	= =
<i>Pirata latitans</i>	7 34	12	1 4	0 4	= =
<i>Trochosa spinipalpis</i>	5 15	— 39	4 18	42 14	
<i>Oxyptila simplex</i>	11 12	14	8 0	20 2	= =
<i>Antistea elegans</i>	14 5	— 0	10 2	0 0	=
<i>Agraecina striata</i>	1 0	— 9	0 2	0 0	= = =

Pl. II - Comparaison des effectifs capturés en 1986 et 1989 par pièges "Barber" pour les principales espèces épigées de la cladiaie. ligne du haut : 1989, ligne du bas : 1986. (Les effectifs sont tous exprimés en nombre d'adultes pour quatre pièges. Tests de chi-deux réalisés sur les données brutes : p<10% :<—>; p<5% :<—>; p<1% :<==>).

par contre présente un effectif nettement plus élevé dans la cladiaie sud. On observe donc des modifications importantes des peuplements d'araignées récoltées au piège "Barber" dans la cladiaie, mais aussi dans la cariçaie et la phragmitaie. Certaines espèces disparaissent, d'autres semblent coloniser un nouveau milieu, les espèces dominantes changent radicalement et, pour une même espèce, une diminution dans un biotope peut correspondre à une augmentation d'effectif dans un autre.

5. DISCUSSION

Le premier cas étudié montre l'importance des *liaisons* qui existent entre les espèces d'araignées et leur habitat. De nombreux auteurs récents ont bien montré que ces invertébrés peuvent être très sensibles à des facteurs écologiques précis comme l'humidité du sol ou de l'air, la luminosité, la texture du sol ou la structure de la végétation. Mais le volume vital de ces animaux étant de faibles dimensions, cette sensibilité peut se traduire par une adéquation à un microhabitat particulier, dont les caractéristiques diffèrent notablement de celles du milieu où il est immergé. Ceci pose un double problème dans le cadre de l'utilisation des araignées en tant que bioindicateurs:

- Les connaissances nécessaires sur l'autécologie des espèces sont obligatoirement tirées de la littérature existante. Or, ces renseignements ne sont utilisables que s'ils présentent un niveau de précision suffisant dans la description du milieu (DUFFEY 1978). Nous voyons maintenant, que dans certains cas au moins, cette précision doit s'étendre à la description des microhabitats occupés par chaque espèce, faute de quoi des erreurs importantes peuvent apparaître dans la définition du préférendum et surtout de l'amplitude d'habitat de ces espèces. Pour cette raison, il est vraisemblable que l'imprécision ou la variabilité notable de l'habitat (ou des exigences écologiques) de certaines espèces, telles qu'on les rapporte dans les ouvrages de synthèse, ne soient souvent qu'un effet de ce problème de microhabitat et qu'il existe, en fait, beaucoup plus d'espèces sténoèces qu'il n'y paraît dans la littérature.
- Lors de l'étude ou du suivi d'un site à l'aide d'araignées bioindicatrices, il est indispensable de garder à l'esprit que ces espèces peuvent être plus indicatrices de conditions très locales que de facteurs stationnels généraux. Une telle précision peut être très utile dans le diagnostic d'une évolution fine du milieu, ou de changements internes de son organisation structurale. Toutefois cela implique un niveau d'analyse suffisant dans l'investigation des biotopes étudiés.

Dans le second cas exposé, nous constatons que des changements de peuplement très importants sont survenus dans plusieurs milieux du Marais entre 1986 et 1989. Divers phénomènes peuvent en être, à priori, la cause.

La première hypothèse, évoquée dès 1986, est la compétition interspécifique entre espèces taxonomiquement proches et de taille ainsi que de moeurs analogues (*Zelotes lutetianus*-*Z. latreillei* ou *Pardosa pullata*-*P. prativaga* par exemple). Mais la

disparition de l'une d'entre elles n'a pas été accompagnée par une augmentation notable de l'autre ; il s'agit même d'une diminution pour *P.prativaga* dans la cladiaie. Par ailleurs, cette explication ne serait pas valable pour les autres araignées concernées, ni pour l'ensemble des trois milieux investigués.

Nous devons rejeter aussi l'hypothèse d'un biais méthodologique, car, outre le soin apporté au piégeage, les variations d'effectifs d'une année sur l'autre se feraient, alors, dans le même sens pour toutes les espèces, ce qui n'est pas du tout le cas.

L'impact des mesures de gestion sur la cladiaie nord et la cariçaie ne peut pas, non plus, être retenu d'une façon générale. Pour la cladiaie nord, l'action du troupeau bovin, atténuée par la position des pièges dans une placette en défens, ne se fait globalement pas sentir. En effet, les nombres d'individus obtenus dans cette station et dans la cladiaie sud (sans bovins) sont équivalents pour pratiquement toutes les espèces étudiées. Seules font exception *Agracina striata* (pour laquelle une étude plus complète des différents milieux de la Réserve fait apparaître un gradient général d'abondance décroissante sud—nord), *Antistea elegans* (qui n'est, au contraire, présente que dans l'ensemble des milieux nord du Marais), et *Trochosa spinipalpis* (dont les effectifs sont également variables dans les deux autres milieux non soumis au pâturage). Le fauchage de la cariçaie en 1987 a pu avoir une certaine influence sur quelques espèces (*Pardosa prativaga*, *Pirata tenuitarsis*, *Trochosa spinipalpis*) mais ces dernières subissent toutes des variations d'effectifs aussi importantes, sinon plus, dans la phragmitaie restée intacte.

Toutes ces causes étant écartées, la seule hypothèse valable, pour expliquer les modifications importantes des peuplements auxquelles nous assistons, reste l'instabilité du milieu. En effet, le Marais de Lavours se trouve affecté par les modifications du régime hydraulique du Rhône et de son affluent, le Séran. Des inondations, rendues encore plus importantes par l'endiguement du Rhône, peuvent se produire à n'importe quelle période de l'année. Elles sont susceptibles d'être très brusques et de recouvrir totalement le marais sous plusieurs décimètres, voire plusieurs mètres d'eau. Une telle inondation eut lieu en juin 1987. Il est vraisemblable qu'un envahissement complet du milieu par un courant d'eau submergeant toute la végétation herbacée, a des effets importants sur les diverses populations d'araignées, surtout s'il survient en pleine période d'activité des adultes. Des diminutions drastiques d'effectifs doivent pénaliser les différentes espèces présentes, avec une intensité aléatoire pour chacune d'elles. La dynamique du peuplement va donc se redévelopper à partir d'un état initial différent après chaque événement catastrophique, et engendrer ainsi des communautés très variables pour un même site au cours du temps.

De fortes modifications dans les peuplements de sites aux conditions extrêmes ont déjà été remarquées (par exemple BUCHAR 1969). Dans certains cas, des conditions climatiques particulières (gel intense par exemple, TARABAJEV 1990) sont la cause de réductions de populations. A Lavours, les crues dévastatrices, brusques, irrégulières et imprévisibles jouent un tel rôle.

L'existence de changements de cette ampleur, dans les peuplements des milieux soumis à des contraintes violentes et aléatoires, pose de sérieux problèmes en bioindication. Il apparaît nécessaire, dans ce cas, de réaliser des études s'étalant sur plusieurs années consécutives. Cela permettra d'observer les tendances évolutives régulières autogènes des peuplements de façon à pouvoir les séparer des discontinuités allogènes. Ce n'est qu'à ce prix qu'il sera possible de détecter les effets induits par les mesures de protection ou de gestion du site et de prévoir son devenir. Par ailleurs, la connaissance même de la nature imprévisible d'un site n'est pas toujours aisée, et non décelable par un unique inventaire annuel. Enfin, cette instabilité des peuplements est un facteur de risque important pour la conservation d'espèces rares présentes sur le site. Pour faire face à ce problème, les mesures de gestion doivent aller dans le sens d'une augmentation de la diversité des biotopes favorables selon le facteur perturbateur en cause (par exemple, à Lavours, favoriser, si possible, le développement de cladiaies restant toujours hors-eaux).

6. CONCLUSION

L'étude du Marais de Lavours a permis de mettre en lumière quelques problèmes quant à l'utilisation des araignées comme bioindicateurs, mais aussi de rappeler que ces animaux sont très sensibles à certaines caractéristiques écologiques et que leur potentiel de bioindication est à la fois bien réel, souvent d'un grand niveau de précision et qu'il intègre des facteurs environnementaux peu mis en évidence par les bioindicateurs plus "classiques", des facteurs aux variations brusques et brèves par exemple. Cependant, la réalisation d'études poursuivies sur plusieurs années consécutives dans de nombreux types d'habitats, et leur confrontation, sera nécessaire pour établir les règles fiables de l'usage de la bioindication aranéologique.

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Data points for a study of population dynamics of an Orb-Weaving spider (*Larinioides cornutus*, Araneae, Araneidae)

par
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Summary: Series of samples have been carried out all over a year in a mesophilous heathland of the west of France. Spiders collected were classified according to the developmental stages. From knowledge on the phenology of the different instars, the developmental patterns of the species have been worked out. *Larinioides cornutus* belongs to the stenochronous species of spring and summer; the survival curve of the population is closely connected to the type III of Deevey. Besides this, laboratory experiments showed that ovarian maturation or embryogenesis are controlled by photoperiod.

1. INTRODUCTION

The orb-weaving spider *Larinioides cornutus* is widely spread in Septentrional Europe (BONNET 1959). In the west of France, we always observe it on higher vegetation of natural wet areas (mesophilous or hygrophilous heathlands, wet grasslands, salt meadows, mixed forest plots, rush-beds...). In Switzerland, this species also show high densities in some agrocoenoses (NYFFELER 1982). However, the knowledge concerning the biological cycle, the fecundity and the species' survival still remain scattered. In a Polish grassland, KAJAK (1965) shows that the highest densities of adults occur in spring; in summer, juvenile instars are highly represented and the medium-sized individuals are the most numerous in autumn. In Germany, KITCHNER (1965) points out that adults and immatures of different size groups spend winter in a state of quiescence. In a cereal field of Switzerland, NYFFELER (1982) shows that the abundance of the population is maximal in spring and at the beginning of summer. Under laboratory conditions, BONNET (1927) notices that one female can lay up to ten times.

No study have been done on the population dynamics. Our former works concerning the development of the species in the laboratory have defined criteria of discrimination of the different postembryonic instars. These new data allow us to follow the demographic evolution and to study the life cycle of a population of the west of France.

2. METHOD

All over the year series of samples have been carried out in a mesophilous heathland of an edge-pond (étang de l'Abbaye, Paimpont, France) in the areas where spiders show the highest densities (consisting mainly of *Juncus effusus* and *molinia coerulea*). At twilight, all the spiders leave their retreats and build their webs. Therefore the successive samplings (from units of 20 m²) take place at nightfall by hand collecting with a torch provided with a red screen. The juveniles of *Larinioides cornutus* are easily recognizable by the characteristical pattern of their carapace. All the spiders collected are classified according to the different stages of development by using patterns of posterior and anterior sides of leg trichobothria (YSNEL 1988). The subadult males and females are respectively characterized by the swell of the tarsi of pedipalps and by the rough shape of the epigyne. The parallel evolution of the number of egg sacs and of the number of females per unit of surface is followed on six different plots (total surface = 150 m²) by marking and counting the cocoons during all the egg-laying period. In the mean time, some more data points concerning the species' fecundity are obtained from the breeding of adult females taken from the spot during different seasons (group I: females collected on 15/12 /1990; group II: females collected on 7/03/1990; group III: females collected on july 1991). Females collected at the end of winter (group II) are divided into two groups and reared under two different light-dark cycles (group IIa, long days: 16 hr light/8 hr dark; group IIb, short days: 8 hr dark/16 hr light). The two groups were kept at 27°C and reared under the same feeding regimen. When the spiders of the third group are caught with their laying, or when they lay less than 48 hours past their capture, we are searching to give an account between the size of the females (length of tibia PIV) and the number of eggs per cocoons.

3. RESULTS AND DISCUSSION

In the case of Argiopidae, the first free-living instar is called J2 (CANARD 1987). For the population studied, it exists from 5 to 8 immatures instars and from 1 to 4 adult stages (figure 1, tableau I).

adult instars	VII	VIII	IX	X
males	31.2%	59.2%	9.4%	0%
females	35.1%	58.8%	4.6%	1.5%

Tab. I - Distribution of males and females per instars.

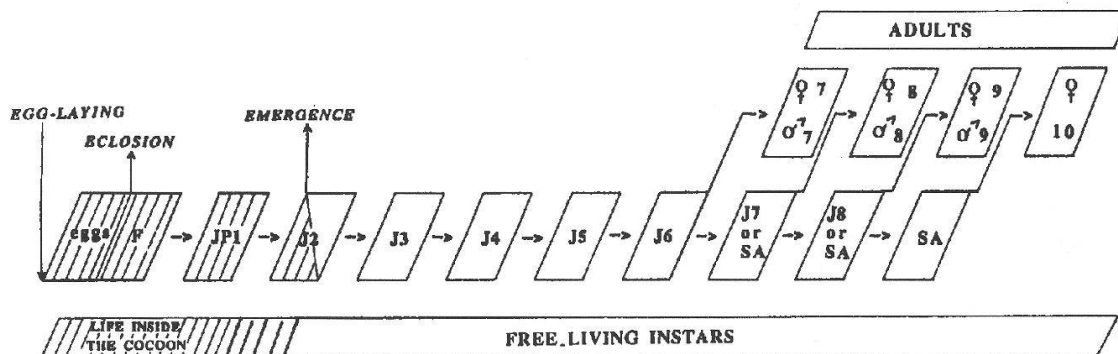


Fig. 1 - Development of *Larinioides cornutus* under natural conditions (west of France). (F: foetal instar; JP1: prejuvenile instar; J: juvenile instar, SA: subadult; ->: moult)

3.1 Number of developmental stages and sexual ratio

Subadults from both sex appear during the 5 th juvenile moult and reach adulthood at stage 7 (31.2% of males and 35.1% of females collected). Roughly 60% of the spiders (males and females) undergo another moult and reach maturity at stage 8. A low proportion of individuals (9.4% of males and 4.6% of females) reach adult stage on the seventh free-living moult (adult 9). Only 2 females (1.5%) reach maturity at stage 10. These variations of the number of postembryonic instars are probably linked with the variations of the environmental conditions throughout the life cycle; they correspond to the variations observed for spiders reared from eggs to adults under different conditions of temperature and feeding regimens (YSNEL 1988; 1990). Adult males do not built webs any more, become wanderers and fastly disappeared after mating; therefore they probably are underestimated in the samples. Supposing that the duration of inter-moult period and the mortality are the very same for the subadults of both sex, we can estimate the sex ratio of the population by using the sex ratio of subadults (table IV). Concerning *Larinioides cornutus*, a non-migrant species, the sex ratio (52 subadult females for 46 subadult males) is nearly 1.

In analysing the distribution of the counted group per instars for the successive samples, we can follow the demographic evolution of the population (figure 2). From the end of spring to the beginning of autumn, the first free-living instars (II,III) become visible and their density increase in summer. The first spiderlings emerging from the

3.2 Demographic evolution

Egg sacs laid from the end of spring to the beginning of summer (cohort C1) reach at least the instar V as early as september, and reach the subadult or adult instars at the beginning of winter (instars VI, VII, VIII). The first free-living instars which appear later in the year (end of summer) form another cohort (C1'); the individuals of the cohort C1' are still immatures in autumn (instars II, III, IV). The latest point of recruitment of young is up in autumn. All the stages of development are settled at the beginning of winter. Low temperatures in winter can stop the postembryonic development, namely for *Larinioides cornutus*; in this case, the spiders enter in quiescence (KIRCHNER 1965). At the end of winter, the structure of the population is only different because of the winter mortality and the development can go on. In spring 1989, all the spiders of the cohort C1 reach the adult stages and can mate. The ones of the cohort C1' become adult at the beginning of summer and they may be confounded with the surviving adults of the cohorts C1. Although the subadult and adult males are very numerous during the captures at the end of summer, they are not very well represented in autumn. So we may suppose that males can mate in autumn (the males

becoming at that time potential preys for the females and so fastly disappear). The cohort C-1 includes adult or subadult spiders which were born at the end of spring 1987. The density of adults is more important in 1989 than in 1988.

So it produces an important variation of the number of spiderlings between the two successive generations.

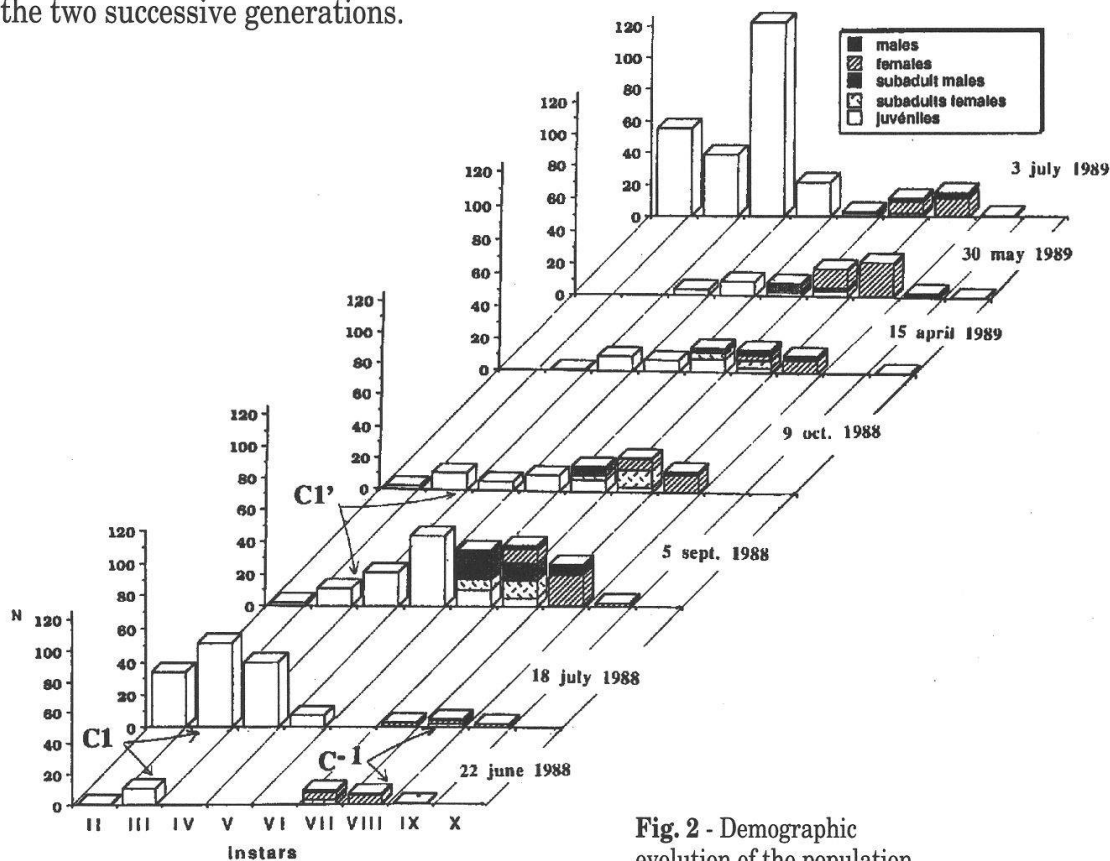


Fig. 2 - Demographic evolution of the population.

3.3 Adult longevity

During those two successive years, the decreasing number of females between the two populations sampled at the end of spring and at the beginning of summer shows that the females adult in autumn (and overwintering in quiescence) die at the end of the following spring. They may live from seven to eighth months. The females adult at the beginning of summer (overwintering as immatures) will live two months and disappear at the end of summer. So it probably explains the decreasing number of females between the samples done in september 1988 and october 1988. Some of the males adult in autumn probably mate at this time and die so they don't live more than one month; the other ones mate next spring and in that case, they can live up to six months. The males reaching the adult instars in spring and in summer can mate right now and their longevity (one month) must be the same than the one of the males mating in autumn.

3.4 Data on fecundity

3.4.1 Fertility of overwintering females and effect of photoperiod on fecundity

All the females collected in winter (group I) and reared under long days at different temperature conditions (from 15°C to 27°C) have laid viable cocoons which prove the existence of a mating period just before winter. Females collected at the end of winter (groups IIa, IIb) show different rates of reproduction (table II). Under short photophases the average number of cocoons per females is significantly inferior (Wilcoxon-Mann-Whitney test, $P < 0.001$). On the other hand, the number of non hatched cocoons is significantly lower under long days (X^2 test, $P < 0.001$)

	Ni	Nc	total egg-sacs	E.G./F	Nh	longevity of females (days)
long days (IIa)	21	19 (90%)	116	6.1	38 (32.7%)	84.2 ± 36.05
short days (IIb)	20	15 (75%)	59	3.9	38 (64.4%)	42.7 ± 35.1

Tab. II - Summary of results concerning the rearing experiments of females of group II. (Ni: initial number of females; Nc: number of females producing egg sacs; E.G./F: average number of egg sac per female; Nh: non-hatched cocoons)

Moreover we observe that the average longevity of females of group II a is significantly higher than those of females of group IIb (Wilcoxon-Mann-Whitney test, $P < 0.002$).

The short photophases inhibit the reproductive possibilities of *Larinioides cornutus*. As mentioned before concerning the others species (YSNEL & CANARD 1990) they are

likely to act on the activity of neurosecretory cells which control, in *L. cornutus*, the ovarian maturation (lack of cocoons or decrease of the number of cocoons), the egg-fertilization or the embryogenesis (sterile eggs production). The lowest longevity of females bred under short photophases could prove that short days disturb the running of the hormonal system of individuals after the ending of quiescence

3.4.2 Number of cocoons per females and number of eggs per cocoons

The parallel evolution of the number of new cocoons and of females picked up on the six plots shows that the egg-laying period spreads out from the end of spring until the beginning of autumn (table III). The number of cocoons is more important in may and july. Among all the retreats recorded, 77% contain one cocoon, 20% two cocoons and only one contains three cocoons; 30.8% are infested with Diptera (Chloropidae) or Hymenoptera (Cryptinae) (Rollard 1987).

	april	may	june	july	aug.	sept.	oct.	nov.
number of egg sacs	0	12	0	14	5	5	1	0
number of females	/	22	21	17	19	14	12	/

Tab. III - Number of egg sacs and females collected on the six diferent plots.

Because short photophases inhibit reproduction in autumn, we will suppose that all the cocoons collected are laid by the females of cohort C-1. The average number of cocoons per females must be evaluated by taking the proportion of new females (F) appeared on the six plots studied throughout the egg-laying period into consideration. If we assume that the rate of mortality is low during the last moult, we can estimate F for two successive samples by refeering to the demographical evolution of subadult and adult individuals during the reproductive period such as: $F = N_{sa\ t} / N_{ad\ t+1}$

(N_{sad} = number of subadults females at time t; $N_{ad\ t+1}$ = number of adult females at times t+1)

The values of N_{sa} and N_{ad} used are reported on table IV

	22 /VI/88	18 /VII/88	5 /IX/88	9 /X/88	15 /IV/89	30 /VI/89	3 /VII/89
subadult females	3	3	19	14	8	4	1
females	11	6	31	18	12	35	19
subadult males	0	0	29	7	4	5	1

Tab. IV - Number of subadults of both sex and number of females collected in each sample.

Moreover we will suppose that the proportions of females appeared between may and the beginning of summer are the same for the years 1988 and 1989. The lack of individuals of stage 6 as early as july 1988 shows that the females of the previous generation (cohort C-1) have disappeared in october 1988. The number of females appeared on the six plots studied must be: $22 + (4/19) (21) + (3/6) (17) + (3/31)(19) = 37$ females. 37 cocoons have been collected; on the average, females lay one egg sac.

There is a good correlation ($r = 0,78$) between the size (x) of the females of group III and the number of eggs per cocoons (Y) ($Y = 143,07x - 112,05$). As, on an average, spiders lay only one egg sac, we will use this relation to estimate the number of eggs laid per females in natural conditions.

3.5 Survival curves

The analysis of the demographic evolution per developmental stages throughout the year allows to characterize three cohorts in the population (table V). The individuals of cohort C1 are issued from the egg sacs laid by the females in May and June 1988; we estimate the number of females living in May 1988 basing on the rate of survival of females (42.8%) between may and june 1989 (that is to say a total of 26+11 females for May and June 1988). Because of the middle size of the females in June 1988 ($x = 1.95 \text{ mm} + 0.5$) we can estimate the number of eggs from which the individuals of cohort C1 come from. The individuals of the cohort C1' are issued from the cocoons laid by the females in july 1988, and according to the proportion of subadults females living in july, from those laid by half of all the females of august (so a total of 6+15= 21 females). The number of eggs laid is estimated from the middle size ($x = 1.98 \text{ mm} + 0.2$) of the females.

instars	II	III	IV	V	VI	VII	VIII	IX	X
	C1					C-1			
22 june 1988	1	11	0	0	0	9	7	1	0
18 july 1988	34	51	10	7	0	3	5	2	0
5 sept. 1988	2	11	21	44	35	38	26	2	0
9 oct. 1988	C1'	2	11	6	10	17	22	13	0
15 april 1989		0	1	12	9	15	14	11	0
30 may 1989		0	0	4	9	8	18	22	3
3 july 1989		39	122	21	3	11	15	1	0

Tab. V - Number of individuals per cohort (years 1988-1989)

The survival curves (figure 3) established from these estimations are closely connected to the type III of DEEVEY (1948).

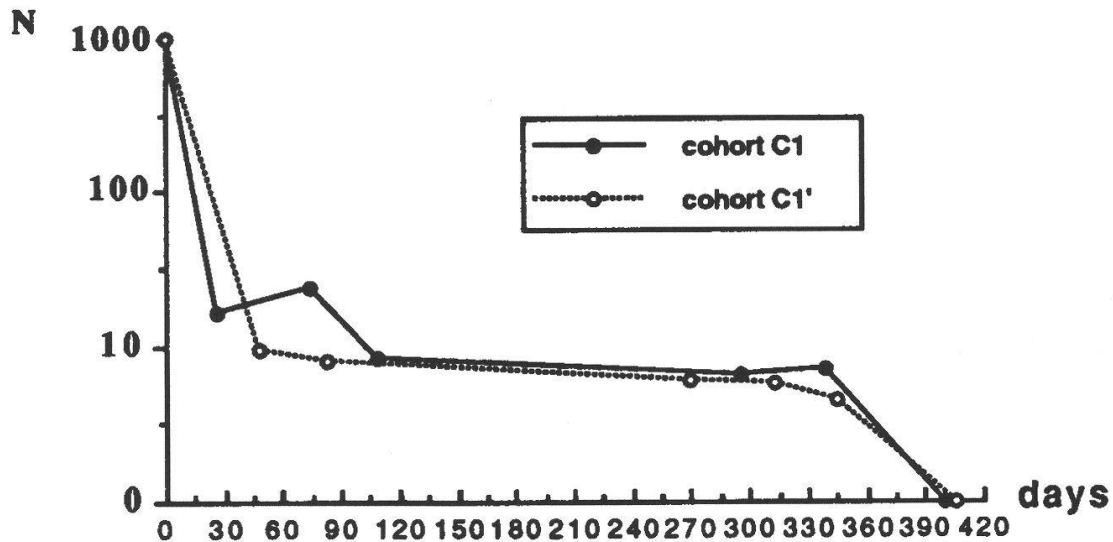


Fig. 3 - Survival curves for the two cohorts (years 1988-1989).

4. CONCLUSION

Taking place among the orb-weaving species, *Larinioides cornutus* belongs to the stenochronous species of spring and summer (YSNEL & CANARD 1986); sexual activity takes place from spring to autumn but the egg-laying period is confined to summer (figure 4). The egg-laying cycles are under the control of regulating mechanisms; the short photophases induce ovarian diapauses which reject the coming out of laying in good conditions. Studying the individuals of a same population, we can establish that the duration of the life cycle (from 6 months to one year), the adults longevity (from one to six months), and the overwintering instars (immatures or adults in a state of quiescence) vary and depend on sex of individuals and on the moment where the first free-living instars appear. Up to that point, the exact studies about the survival curves of the spiders concerned mainly the wanderers spiders (BLANDIN & CELERIER 1986); with regard to the orb-weaving spider *Larinioides cornutus*, the demographic analysis allow to assimilate the variations of numbers of spiders per cohort as a survival curve of type III, with a very high rate of mortality at the beginning of the development, connected to the high proportion (30.8%) of parasitized cocoons, then a low and constant rate of mortality for the end of the development. The seasonal regulation of the egg-laying cycles may imply that the rate of reproduction stay the same from a generation to another for the females of the same size; the variations of number of adults studied for both successive generations may be more dependant on the winter mortality during the postembryonic development.

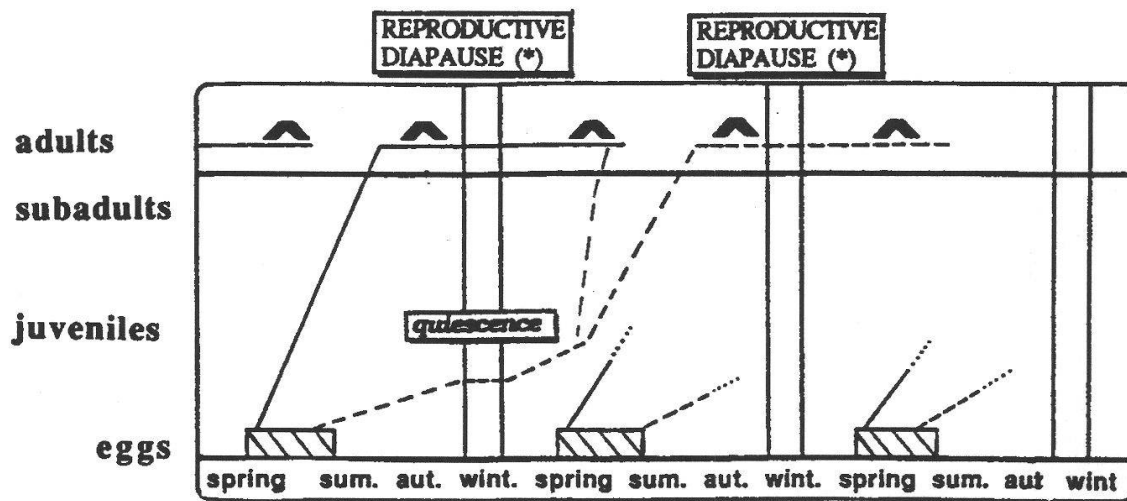


Fig. 4 - Life-history patterns of *Larinioides cornutus* in the west France.

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The spider fauna of the Karatau mountain range

par

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The Karatau (or the Syr Darya Karatau) mountain range is the extreme north-western spur of Tien Shang and has its length above 400 km. Thanks to the unique geographical situation of Karatau, strongly wedging in the desert zone, and its considerable geological age the Karatau range has a number of endemic insects (PRAVDIN 1978): among mammals the endemic Karatau mountain sheep occur here. As to the endemic plants, the Karatau mountain range takes the first place among the other floristic areas of Kazakhstan (GVOZDEV, ANDREJTCHUK 1988).

The present paper includes the results of the determination of spiders collected by the authors in 1988-1989.

The spider fauna of the Karatau up to the last years was an absolute white spot: only recently MARUSIK and LOGUNOV (1990) registered here 6 species of the family Thomisidae from our collections; all these are presented in the Table 1.

During 1988-1989 we collected 110 species of spiders belonging to 83 genera from 24 families (Table 1). The representatives of the families Oecobiidae, Filistatidae, Oonopidae, as well as 10 genera and 17 species, are new for the Kazakhstan fauna: the last make up 15,5 per cent of the total number. Non-determined specimens designated as "sp" (44 species from 17 families, or 40,0 %) presumably are new species.

The most of the species collected (69, or 62,7 %) are rare (isolated) ones. At the same time, some species are usual and constant (31, or 28,2%: see Table 1). The dominating species are the four ones: *Mogrus antonius* (Salticidae), *Agelena orientalis* (Agelenidae), *Pardosa turkestanica* (Lycosidae), *Neoscona adianta* (Araneidae).

Table 1.- Species composition and relative abundance of spiders at Karatau mountain range

Families, species		Relative abundance
	*1. Oecobiidae	
K*	1 <i>Ambika nadiae</i> (Spas.)	+
	2. Eresidae	
	2 <i>Eresus niger</i> (Pet.)	+
K	3 <i>Stegodyphus lineatus</i> (Latr.)	++
	*3. Filistatidae	
K*	4 <i>Pritha crosbyi</i> (Spas.)	++
	*5 <i>Zaitunia</i> sp.	+
	4. Dictynidae	
	6 <i>Archaeodictyna</i> sp.	+
	7 <i>Brigittae latens</i> (Fabr.)+	
K	8 <i>B. innocens</i> (O.P.-C)	+
	*9 <i>Nigma</i> sp.	+
	10 <i>Lathys puta</i> (O.P.-C.)	++
	5. Titanoecidae	
	11 <i>Titanoeca veteranica</i> Herm.	+
	12 <i>Nursicia albosignata</i> Sim.	+
	6. Uloboridae	
	13 <i>Uloborus walckenaerus</i> Latr.	+
	7. Pholcidae	
K	14 <i>Pholcus ponticus</i> Thor.	++
	8. Palpimanidae	
	15 <i>Palpimanus</i> sp.	+
	*9. Oonopidae	
K*	16 <i>Dysderina loricata</i> (Sim.)	+
	10. Salticidae	
	17 <i>Synageles ramitus</i> Andr.	+
	18 <i>Pellenes seriatus</i> (Thor.)	+
	19 <i>Aelurillus ater</i> (Kroneb.)	++
	20 <i>Philaeus chrysps</i> (Poda)	++
	21 <i>Mogrus antoninus</i> Andr.	+++
	22 <i>Phlegra sogdiana</i> Charit.	+
	23 <i>Ph.sp.</i>	+
	24 <i>Chalcoscirtus</i> sp.	++
	25 <i>Bianor</i> sp.	+

Families, species	Relative abundance
26 <i>Euophrys nigrita</i> (Thor.)	+
27 <i>E.sp.</i>	++
28 <i>Heliophanus potanini</i> Schenk.	++
11. Gnaphosidae	
29 <i>Gnaphosa sp. 1</i>	+
30 <i>G.sp.2</i>	+
31 <i>G.sp.3</i>	+
K 32 <i>Leptodrassus memorialis</i> Spas.	+
33 <i>Drassodes sp.</i>	+
34 <i>Haplodrassus sp.</i>	+
35 <i>Synaphosus turanicus</i> Ovt.	++
36 <i>Talanites sp.</i>	+
K *37 <i>Phaeocedus braccatus</i> (L.Koch)	+
K 38 <i>Ph. rufescens</i> (Kroneb.)	+
39 <i>Zelotes jaxartensis</i> (Kroneb.)	+
40 <i>Z. praeficus</i> (L.Koch)	++
41 <i>Z.sp.1</i> (pr.puritanus)	+
42 <i>Z.sp.2</i> (pr.atrocoeruleus)	+
K 43 <i>Aphantaulax seminigra</i> Sim.	+
K 44 <i>Micaria albimana</i> O.P.-C	+
45 <i>M. formicaria</i> (Sund.)	++
K 46 <i>M. septempunctata</i> O.P.-C	+
12. Philodromidae	
47 <i>Philodromus sp.1</i>	+
48 <i>Ph.sp.2</i>	+
49 <i>Thanatus sp.1</i>	+
50 <i>Th.sp.2</i>	++
13. Thomisidae	
51 <i>Thomisus onustus</i> Walck.	+
52 <i>Runcinia tarabayevi</i> Marus., Log.	+
53 <i>Xysticus cristatus</i> (Cl.)	+
54 <i>X.sabulosus</i> (Hahn)	++
55 <i>S.turanicus</i> Charit.	+
56 <i>X.turlan</i> Marus., Log.	+
14. Clubionidae	
57 <i>Chiracanthium sp.1</i>	+
58 <i>Ch.sp.2</i>	++
K *59 <i>Phrurolithus pullatus</i> Kulcz.	++
15. Liocranidae	

Families, species		Relative abundance
*60	<i>Mesiotelus</i> sp.	++
*61	<i>Castianeira</i> sp.1	++
62	<i>C.sp.2</i>	+
16. Theridiidae		
63	<i>Latrodectus tredecimguttatus</i> (Ros.)	++
64	<i>Steatoda paykulliana</i> (Walck.)	++
65	<i>Lithyphantes albomaculatus</i> (De Geer)	++
66	<i>Teutana triangulosa</i> (Walck.)	++
67	<i>Theridion varians</i> Hahn	++
68	<i>Enoplognatha ovata</i> (Cl.)	+
69	<i>E.sp.</i>	++
70	<i>Euryopsis</i> sp.	+
71	<i>Robertus</i> sp.	+
17. Oxyopidae		
72	<i>Oxyopes</i> sp.	+
18. Zodariidae		
73	<i>Zodarion</i> sp.1	++
74	<i>Z.sp.2</i>	+
75	<i>Z.sp.3</i>	+
19. Agelenidae		
K 76	<i>Agelena orientalis</i> C.L.Koch	+++
K 77	<i>A.marakandensis</i> (Charit.)	+
78	<i>Coelotes</i> sp.	+
20. Hahniidae		
79	<i>Hahnia</i> sp.1	+
80	<i>H.sp.2</i>	++
21. Lycosidae		
81	<i>Lycosa nordmanni</i> (Thor.)	++
82	<i>L.sp.</i>	++
83	<i>Allohogna singoriensis</i> (Laxam.)	+
84	" <i>Geolycosa</i> " sp.1	+
85	" <i>G.</i> " sp.2	+
86	<i>Alopecosa</i> sp.	+
87	<i>Arctosa leopardus</i> (Sund.)	++
88	<i>Pirata</i> sp.	++
89	<i>Evippa</i> sp.	++
90	<i>Pardosa turkestanica</i> (Roew.)	+++
22. Araneidae		
91	<i>Argiope lobata</i> (Pall.)	++

Families, species	Relative abundance
92 <i>Larinioides folium</i> (Schr.)	++
93 <i>Agalenatea redii</i> (Scop.)	+
94 <i>Aculepeira</i> sp.	+
95 <i>Neoscona adianta</i> (Walck.)	+++
96 <i>Mangora acalypha</i> (Walck.)	+
97 <i>Zygiella caspica</i> (Sim.)	++
23. Tetragnathidae	
98 <i>Tetragnatha extensa</i> (L.)	++
99 <i>Pachygnatha clercki</i> Sund.	+
24. Linyphiidae	
100 <i>Microlinyphia pusilla</i> (Sund.)	++
101 <i>Agyneta</i> (<i>Agyneta</i>) sp.	+
102 <i>A. (Meioneta) fuscipalpis</i> (C.L.Koch)	+
K 103 <i>Lepthyphantes kuhitangensis</i> Tanas.	+
K 104 <i>L. tchatkalensis</i> Tanas.	+
105 <i>Bolyphantes indexoides</i> Tanas.	+
106 <i>Erigone dentipalpis</i> (Wid., Reuss.)	+
107 <i>Oedothorax apicatus</i> (Blackw.)	+
108 <i>Ceratinopsis romana</i> (O.P.-C.)	+
109 <i>Mesasigone mira</i> Tanas.	+
*110 <i>Trachelocamptus</i> sp.	+

Total: 110 species, 24 families, 83 genera

- + - rare (isolated) species
- ++ - usual species
- +++ - dominating species
- * - families and genera new for Kazakhstan
- K - species new for Kazakhstan

The most numerous as to the number of species are the families Gnaphosidae (18 species, or 16,4%), Salticidae (12-10,9), Linyphiidae (11-10,0), Oycosidae (10-9,1), Theridiidae (9-8,2), Araneidae (7-6,4), Thomisidae (6 species, or 5,5 per cent), and as to the generic diversity the families Gnaphosidae and Salticidae (10 Genera), Linyphiidae (9), Lycosidae and Theridiidae (in 8), Araneidae (7 genera).

The main part of the species collected constitute geobionts (the spiders living in soil and on the ground surface): these are 84 species, or 76,4 per cent of the total number of species - the representatives of the families Titanoecidae, Pholcidae, Palpimanidae,

Oonopidae, Salticidae (except the genera *Synageles*, *Mogrus*, *Heliophanus*), Gnaphosidae (except *Aphantaulax*), Hahniidae, Lycosidae, Linyphiidae (except *Microlinyphia*) and the genera *Eresus* (Eresidae), *Zaitunia* (Filistatidae), *Lathys* (Dictynidae), *Xysticus* (Thomisidae), *Phrurolithus* (Slubionidae), *Zygiella* (Araneidae), *Pachygnatha* (Tetragnathidae). The most of geobionts are the species hiding from the sunrays under stones: these are the representatives of above mentioned families and genera, except the families Salticidae, Philodromidae and genera *Castianeira* (Liocranidae), *Agelena* (Agelenidae), *Pardosa* (Lycosidae), active under bright light. The separate group of geobionts constitute the species burrowing deep holes - trypanobionts (trupa-the hole): these are the species of the genera *Lycosa*, *Allohogna* and "Geolycosa" (Lycosidae). Some geobionts are strictly limited to their specific habitats (stenobionts). Thus, *Pardosa turkestanica* (Lycosidae) lives among stones and in a grass along the banks of streams. The lycosids *Arctosa leopardus* and *Pirata* sp. prefer marshy places. The species *Evippa* sp. (Lycosidae), living on screes, and *Xysticus turanicus* (Thomisidae), are typical petrobionts having uniform grey colour (Araneidae) builds its webs on the cracked rocks. *Castianeira* spp. (Liocranidae) live only in the *Scyrcus* along the streams.

Phytobionts (plant inhabitants) are basically represented by the hortobionts (grass inhabitants): these are the species of the genera *Archaeodictyna*, *Brigittea* (Dictynidae), *Synageles*, *Heliophanus* (Salticidae), *Aphantaulax* (Gnaphosidae), *Thomisus*, *Runcinia* (Thomisidae), *Chiracanthium* (Clubionidae), *Oxyopes* (Oxyopidae), *Larinioides*, *Agelenatea*, *Neoscona*, *Mangora* (Araneidae), *Tetragnatha* (Tetragnathidae), *Microlinyphia* (Linyphiidae). The inhabitants of bushes and low trees (thamnobionts) are represented by the genera *Uloborus* (Uloboridae), *Stegodyphus* (Eresidae), *Mogrus* (Salticidae), *Argiope*, *Aculepeira* (Araneidae).

The species *Pritha crosbyi* (Filistatidae), inhabiting the wall cracks, and *Ambika nadiae* (Oecobiidae), are synanthropic ones.

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The trapdoor-burrow: the success of a defense system

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1. INTRODUCTION

In this presentation I will not follow the subordinal classification of spiders worked out by PLATNICK and GERTSCH (1976). Instead I will use the terms Orthognatha and Labidognatha to indicate the suborders of spiders because I believe this is more correct.

An important task in biology is to unravel the course evolution has taken in the various groups of organisms. The cladistic approach currently plays a dominant role in spider taxonomy. This approach aims at constructing phylogenies from which the evolution of spiders can be read.

The information used is strictly morphological and ignores other arguments that may shed light on the evolutionary history of the group. Spiders however possess the uncommon quality of producing constructs (webs, eggsacs, retreats, nests, burrows etc.) that have a morphology of their own. As students of spiders, we are therefore in the favourable position to use the extra information contained in the morphology and functioning of spider constructs to reconstruct the evolution of spiders. Theoretically, if we knew enough about the morphology and functioning of spider constructs we could work out their probable phylogenetic relationships to test hypotheses of different origin.

This is of course nothing new. Starting with POCOCK (1895), arachnologists through time have built hypothetical evolutionary sequences of web types. In the work of POCOCK (1895), BRISTOWE (1958), SAVORY (1960) and KASTON (1964), to name a few of the most prominent, the effort was always aimed at explaining the evolution of the orb web. Araneomorph spiders and their constructs were the focus of attention; information on the constructs of mygalomorphs and liphistiomorphs was only marginally considered. What the web is for araneomorph spiders however, is the trapdoor burrow for mygalomorphs and liphistiomorphs (Orthognatha).

MOGGRIDGE (1873, 1874) already showed that various types of trapdoor burrows are as readily distinguishable as are the various types of webs.

The evolutionary sequencing of burrow types has to my knowledge, in contrast to that of web types, never been attempted. I am not going to make such an attempt now, because I believe too little is known at present of Orthognath spider constructs to do so. What I will do however is to point at a few remarkable differences between Labidognatha and Orthognatha that may be considered in future attempts to reconstruct the evolution of spiders.

2. THE TAXONOMICAL PERSPECTIVE

Looking at the taxonomical qualities of spider constructs, it becomes quickly apparent that the relationships that exist within the Labidognatha, do not exist within the Orthognatha. What I mean is that within the Labidognatha particular types of constructs are built by members of particular families. In other words, types of constructs within the Labidognatha are usually specific at the family level; or members of a particular family generally produce similar types of constructs. This is in contrast to the situation within the Orthognatha.

RAVEN (1985) in his reclassification of the Mygalomorphae, recognizes 15 families. Adding to this number the lyphistiomorph families Liphistiidae and Heptathelidae, we obtain a total number of 17 orthognath spider families alive today. Members of no less than 11 out of these 17 families are known to construct trapdoor burrows. So if we consider the trapdoor burrow as one specific type of spider construct, it is rather typical for the whole suborder than it is specific to any one orthognath family.

A trapdoor is a hinged lid that closes off the entrance of the spider's nest. Usually this nest is a burrow, that is a hole the spider has actively dug out in the ground, or in some other substrate, to provide a living space. The construction of burrows is even more widely spread within the Orthognatha than is the construction of trapdoors. Members of 14 out of the 17 orthognath families are known to construct burrows. Only the micro-mygalomorphs of the families Microstigmatidae and Mecicobothriidae are not known to excavate burrows. The habits of the one remaining family, the Paratropidae, remain obscure in this respect. From the above though it may be safely concluded that burrowing in general and the construction of trapdoor burrows in particular is a dominant feature of the Orthognatha, if not to typify the suborder.

The lack of family-level specificity of spider constructs is not only apparent in the occurrence of particular types of constructs in several families, it is also apparent from the fact that within orthognath families different genera or species build different types of constructs. Theraphosidae for example may dig burrows in the ground or construct elaborate and complicated silken nests in elevated positions. Other members of this family appear to construct no nests at all. For the family Anthrodiaetidae, COYLE (1986)

describes 3 distinct burrow types that are partly genus-specific. *Antrodiaetus* species construct burrows with a collapsable collar entrance, *Atypoides* species either make a collapsable collar or a rigid turret entrance to the burrow and *Aliatypus* species construct a trapdoor. As already illustrated by the example of *Atypoides*, even at the level of the genus, Orthognatha may construct a diversity of burrow and nest types. COYLE (1986) provides a list of 12 orthognath genera of which member species build distinctly different types of constructs. From my own experience I may add the genera *Nemesia*, *Cyrtocarenum*, *Ancylotrippa* and *Ummidia* to this list and a search in the literature will undoubtedly produce many more.

I mentioned this to illustrate that the situation with respect to the existence of a relationship between taxonomical identity and construct type in the Orthognatha is very different from that in Labidognatha. It is impossible to rank orthognath families on grounds of the constructs they produce in a sequence that suggests a progressive evolutionary development, as has been done for Labidognatha in the earlier mentioned works of POCOCK, BRISTOWE, SAVORY and KASTON. Rather it seems that in the Orthognatha we observe a number of different more or less parallel evolutionary lines in different families or family-groups. Virtually all these lines include a burrowing stage and generally also a stage of trapdoor construction. The frequent occurrence of the burrow and the trapdoor throughout the families composing the suborder indicates that these structures are plesiomorphic within the Orthognatha.

3. THE HABITAT PERSPECTIVE

Mentioning the work of MOGGRIDGE (1873, 1874) I have already indicated that distinctly different types of orthognath spider burrows do exist. In its simplest form the burrow is a open hole of a few centimeters deep. The main variation in burrow types is produced by:

- 1) the variation in entrance structures (several types of trapdoors, silken collars, purse webs, sheet webs, etc.)
- 2) the variation in internal structures (internal doors, plugs, silken socks, etc.)
- 3) the variation in shaft morphology (side diggings, underground rooms, escape passages, etc.)
- 4) the variation in the degree of wall plastering and silk lining.

If the type of burrow a spider builds cannot be predicted from knowing its taxanomial status, what might dictate the particular burrow type a particular spider is going to construct?

Most specialists that have considered the question agree that the type of orthognath burrow found in a particular habitat is somehow related to the prevailing environmental conditions. Here again a conspicuous difference between the Labidognatha and the Orthognatha seems to exist. While orb webs, sheet webs, lattice webs, and other labido-

gnath web types may be found in a variety of habitat types without their constructive detail being very dissimilar, the type of orthognath burrow found in a particular habitat generally has particular characteristics. Discussing the Australian trapdoor spider genus *Aganippe* (family Idiopidae), MAIN (1976) states for example: "I discovered a whole array of related forms, each with its own distinctive type of burrow which occurred in a distinctive sort of habitat."

Drawing from my own experience, I found that burrows in open, exposed and dry habitats generally are deeper and have a simpler shaft form than burrows found in more shady, humid forest habitat. Moreover, burrows in open, exposed and dry habitats usually possess a relatively thick, tightly fitting trapdoor, whereas burrows in more shady, humid forest habitats tend to have thin, flexible trapdoors, collapsable collars or plain open entrances.

Understanding the habitat relations of particular types of burrows depends on understanding the functions of the various structures involved (trapdoors, silken collars, webs, underground rooms, etc.). Much still has to be learned in this respect. Broadly speaking however students of orthognath spiders agree that the burrowing habit essentially functions as an escape from adverse microclimatological surface conditions. Although the trapdoor burrow serves also as a defense against predators and even may have an offensive quality, providing a camouflaged ambush site, its primary function lies in the shelter it provides from hazardous climatological conditions.

It is remarkable though that a tribe of obligate predators such as the Orthognatha, should be characterized by a primarily defensive life strategy. The results of experiments by COYLE (1986), in which he showed that the presence of a trapdoor actually obstructs the spider's chances of capturing prey however supports this unlikely view. I also found this negative effect of the trapdoor on prey capture efficiency of Panamanian trapdoor spiders (DECAE, unpubl.).

4. LONGEVITY

A third conspicuous difference between Orthognatha and Labidognatha is the fact that orthognath females remain reproductively active for a number of years after reaching adulthood. In the literature this has also been seen as an adaptation to survive adverse environmental conditions. Because a population of orthognath spiders is typically composed of different yearclasses the population can survive consecutive years in which the conditions are never sufficiently favourable to even mate.

According to MAIN (1976) it will take at least 4 consecutive barren years to destroy a male population of trapdoor spiders. This quality would give the population the ability to survive long periods of hostile climatological conditions.

5. CONCLUSIONS

In summary, I have discussed three subjects that in my opinion illustrate important differences between the Orthognatha and the Labidognatha.

I believe these differences tell something about the different evolutionary histories of the two suborders of spiders.

Firstly the lack of family level specificity of construct types in Orthognatha indicates that this suborder much less than the Labidognatha represents an evolutionary unity exhibiting one or a few coherent lines of development.

Secondly, the strong habitat specificity of construct types in Orthognatha, when compared to the Labidognatha, indicates a lower degree of physiological adaptation to terrestrial environments in Orthognatha, that is compensated for by behavioural specialization, a behavioural specialization however that allows orthognath spiders to efficiently escape from even the most extreme surface conditions.

The longevity of Orthognatha finally reinforces their capabilities to endure long periods of harsh conditions. The habit of constructing strongly isolating trapdoor burrows, their longevity and the capability of remaining underground for prolonged periods classifies the Orthognatha as a race of spiders that is specialized to persist under circumstances of extreme physical environmental threat.

Departing from the point of view that the Orthognatha are ancestral to the Labidognatha, and taking into account the paleontological evidence that Orthognatha were among the early colonists of the land, it is suggestive to think that their qualities of endurance are linked to the dramatic changes of habitat the first terrestrial creatures had to withstand. The apparent plesiomorphy of the trapdoor burrow and its probable vital role in the survival strategy of this group, makes the burrow the most likely spider construct to have been present at the time the spiders originated.

I make this point because in recent publications (e.g. SHEAR 1986) it is still maintained that the initial spider construct may have been a silken cell spun in a crevice or some other sheltered position. I have argued before (DECAE 1984) that this sheltered position most probably was a burrow actively excavated by the spider.

The foremost distinguishing character to separate the Orthognatha from the Labidognatha, the orthognath chelicerae, in these early days of spiders functioned as they still function today, as specialized tools for digging holes in the ground.

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Springspinnen Interessante Beobachtungen bei der Haltung und Zucht von Salticiden

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NOTES

In our poster we show some photos of nice salticids. If you keep and breed Salticids you see some interesting things. In the last years we have looked how long adults can live and how many eggs are in egg-sacs.

Bezüglich ihres guten Sehvermögens, ihrer Reaktionsfähigkeit und nicht zuletzt ihrer Anpassungsfähigkeit wegen sind die Springspinnen immer wieder Objekte verschiedenster kleinerer und größerer Forschungsprojekte. Wir fanden kaum Literatur, wie alt diese Tiere eigentlich werden können. Daneben gibt es auch kaum Beschreibungen, wie viele Eier ein Tier legt, sprich, wie groß die Nachkommenschaft dieser kleinen und sehr kleinen Spinnen ist. Wir beobachteten und züchteten nun Arten verschiedenster Herkunft und unterschiedlichster Gattungen. Dabei machten wir recht eindrucksvolle Beobachtungen. Besonders hervorheben wollen wir die Langlebigkeit einzelner Arten im adulten Zustand. Um eine gewisse Übersichtlichkeit zu gewährleisten, fassten wir unsere Ergebnisse in Form von Tabellen zusammen.

Tabelle 1. - Hier ist angegeben, wie viele Eier wir pro Kokon zählen konnten. Die kleinere Zahl gibt an, welche Eizahl die kleinste war, die wir zählten, die große Zahl gibt die Rekorde an, die wir an Eiern in Gelegen fanden.

Species	Anzahl der Eier pro Gelege
<i>Salticus scenicus</i>	8 - 22
<i>Philaeus chrysops</i>	4 - 15
<i>Portia fimbriata</i>	6 - 24
<i>Sitticus floricola</i>	3 - 9
Spec. 1 ex Kasachstan	4 - 7
Spec. 2 ex Agadir	3 - 5
Spec. 3 ex Kairo	8 - 32!

Tabelle 2. - In dieser Tabelle ist angegeben, wie alt adulte Salticiden (gerechnet ab der Reifehäutung) bei uns wurden. An Nahrung reichten wir *Drosophila*, verschiedene Grillen und Fliegenarten.

Species	Lebensdauer der adulten Tiere in Monaten	
<i>Salticus scenicus</i>	bis	15
<i>Phlegma v-insignata</i>	bis	8
<i>Philaeus chrysops</i>	bis	4
<i>Portia fimbriata</i>	bis	18!
<i>Phidippus regius</i>	bis	11
<i>Marpissa muscosa</i>	bis	4
<i>Bianor auROCinctus</i>	bis	6
<i>Sitticus floricola</i>	bis	3

Bei der Haltung konnten wir auch interessante Verhaltensweisen feststellen. So beobachteten wir, daß junge *Portia*'s auch zusammen an Beuteinsekten fressen, daß *Phidippus regius* große Insekten teilweise zu 2 oder 3 jagt.

Literatur: bei den Verfassern !

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Neue Erfahrungen mit Giftspinnen

Dirk Zwörner-Weickmann & Sabine Moosmann

NOTES

1. INTRODUCTION

In our poster we want show some rare venomous spiders. In the last years we saw that a lot of scientists not know what *Sicarius* is. A lot of Arachnologists have the meaning if they see a cuticula they see a died spider. With our poster we want say that some things should be basic - one is to see spiders and to identify some venomous spiders, for example *Loxosceles* or *Sicarius*. Nevertheless we can say that venomous spiders are very interesting to observe.

2. LATRODECTUS SP.

Von unserem Besuch in Alma-Ata bei Dr. Chingis Tarabaev und bei Dr. Alexej Zyuzin brachten wir einen *Latrodectus* mit, von dem wir zunächst annahmen, daß es sich um *Latrodectus lugubris* handelt. Nach Paarungsversuchen mit *L. lugubris* unserer Stämme aus Marokko und Spanien kann es sich nicht um *lugubris* handeln. Alle Paarungsversuche liefen erfolglos ab. Männchen der echten *lugubris* hatten kein Interesse an den Weibchen von der *Latrodectus* aus Kasachstan!! Auch Paarungsversuche mit dem *Latrodectus mactans tredecimguttatus* liefen erfolglos ab, was heißen soll, daß die Männchen an den jeweils anderen Weibchen kein Interesse hatten. Zur Giftigkeit ist zu sagen, daß öfters Todesfälle bei Pferden und Kamelen zu beklagen sind, da diese beim weiden oft diese Witwen, die ihre Netze ca. bis 15 cm über dem Boden bauen, mitfressen und dann in die Lippen gebissen werden.

3. LATRODECTUS HESPERUS

Nach Versuchen mit einer Menge Tieren aus Utah, Texas, New York konnten wir feststellen, daß es sich bei *L. hesperus* innerhalb der Latrodecten um eine Gruppe ähnlich der *mactans* - oder *geometricus* - Gruppe handeln muß. Bei den Versuchen handelte es sich um Paarungsversuche.

4. LOXOSCELES SPINICEPS

Diese südafrikanische *Loxosceles*-Art ist im Habitus etwa mit *Scytodes longipes* zu vergleichen. Diese Species gehört zu den sehr giftigen *Loxosceles*-Arten (Dr. Gerry Newlands). Ihr Gift ruft starke und sehr starke örtliche Nekrosen hervor. Bei der Haltung von *L. spiniceps* konnten wir Interessantes feststellen. Nach der Paarung kann ein Weibchen bis zu 11 (größte Zahl bei uns) Kokons bauen. Pro Kokon befinden sich 3-8 Eier. Die Jungspinnen schlüpfen nach 20-54 Tagen. Bei guter Fütterung und bei Temperaturen um 26 Grad Celsius sind die Tiere nach ca. 60 Tagen adult. Adulte Tiere (auch Männchen) wurden bei uns bis zu 6 Jahren alt (einige Tiere leben nun - 1991 - das 7. Jahr!).

5. PHONEUTRIA BOLIVIENSIS

Diese Kammspinnenart weist bei uns so gut wie keine Aggressivität auf. Adulte Weibchen wurden bei uns schon bis zu 5,5 Jahren alt. Im Gegensatz zu *Phoneutria nigriventer* fanden wir bei *P. boliviensis* höchstens 60 Eier pro Gelege. Einmal gebissene Mehlkäfer starben nach bis zu 60 Minuten!! Unsere Tiere nahmen auch tote Insekten an.

Sicarius sp.: Diese *Sicarius*-Art aus Argentinien bekamen wir 1987 und 1988 je in Form eines adulten weiblichen Tieres. An Insekten testeten wir grob die Giftigkeit. Als Versuchstiere nahmen wir gewogene *Acheta domestica*. Bei diesen Versuchen - es handelt sich um Beißversuche - ist die Giftigkeit weit unter der, der afrikanischen *Sicarius*-Arten. Es ist noch zu testen, wie gefährlich Giftcocktail und Toxin für den Menschen sind.

6. SICARIUS TESTACEUS

Diese Art scheint eine wirkliche Giftspinne zu sein. Gebissene Mäuse starben unter heftigen Krämpfen und sehr starken Nekrosen (nach ca. 10 Minuten 2 DM-Stück groß) nach 13 (2 15g Mäuse) bis 45 Minuten (20g Maus). Jedoch war es sehr schwierig, die *Sicarius* zum beißen zu bewegen. Bei allen *Sicarius*-Arten konnten wir feststellen, daß die Weibchen nach der Kopulation Kokons erst nach bis zu 15 Monaten bauten.

Bei unserer argent. *Sicarius*-Spec. hat sich ein Weibchen vor dem Kokonbau sogar noch gehäutet!! Nach ca. 8 Wochen schlüpften aus den Kokons bis zu 15 Jungspinnen. Das typische Eingraben in Sand konnten wir erst nach der 3. Häutung beobachten.

In unserem Poster und in diesem vorliegenden Bericht stellen wir einige, wie uns scheint, interessante Beobachtungen vor, die wir in den letzten Jahren bei der Haltung von "Gift"-spinnen gemacht haben.

NOTES

Literatur: bei den Verfassern !

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Silk of the nuptial gift of the spider *Pisaura mirabilis*.

Andreas Lang

Adult males of the spider *Pisaura mirabilis* wrap up prey with silk and carry these nuptial gifts in search of females. They pass these gifts to females before mating. The females digest the prey as well as the silk during copulation. Recent work on the significance of the nuptial gift of *Pisaura mirabilis* has shown that larger gifts result in longer copulations and higher male reproductive success (Austad, pers. commun.). Nothing is known, however, about the function of the silk in the context of sexual selection.

The results show that male *Pisaura mirabilis* invest little silk in nuptial gifts (mean $\pm$ standard error: 0.04 ± 0.005 mg). The major factors determining the amount of silk are male body size and time available for wrapping up the prey. The size of the prey, the nutritional status of the male, and female body size are less important. The small contribution of the silk to the nuptial gift suggests that the silk is of little nutritional value to the females. But the more silk a nuptial gift contains the longer it takes the female to digest it. Therefore the silk may serve as a mean to prolong feeding time of the females during mating and consequently copulation time. This would increase the reproductive success of the males.

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Zur Gattung *Cybaeus* im Alpenraum (Araneae: Agelenidae, Cybaeinae)

Richard Maurer

ZUSAMMENFASSUNG

Neue Funde von *Cybaeus* in den Südalpen führten zu einer Überprüfung der südeuropäischen Arten: *C. angustiarum* L. KOCH ist auf Mitteleuropa nördlich der Alpen und Osteuropa beschränkt. Der bisherige "*C. angustiarum*" der Südalpen zerfällt in *C. montanus* n.sp. und *C. intermedius* n.sp., die Tiere der französischen Pyrenäen sind als *C. raymondi* SIMON 1916 zu bezeichnen (von SIMON anlässlich der Erstbeschreibung zu *Cicurina* gestellt). *C. minorsensu* BRIGNOLI 1978 (Türkei) ist eine distinkte Art, die mit *C. brignolii* benannt wird. *C. minor*, *C. intermedius* und *C. montanus* bilden die minor-Gruppe, welcher *C. vignai* (Meeralpen) und *C. raymondi* (Pyrenäen) nahestehen. Für *Cybaeus* als Gattung montaner Waldgesellschaften wird präglaziale Einwanderung aus Osten erwogen, für die südwestlichen und südlichen Arten glaziale Überdauerung der Vorläufer in Reliktpopulationen.

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