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The Parasitological, Medical and Veterinary Importance of Coleoptera.

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Though being much less important than the Diptera or the Hemiptera, the order Coleoptera has nevertheless some importance in Parasitology and Medicine which is too frequently overlooked. It is this unusual aspect of Coleopterology that we want to point out here.

Coleoptera as Parasites and Pseudoparasites [1].

There are some beetles having ectoparasitic habits and living on mammals; an almost complete list of them is given in PAULIAN (1943) and we shall quote here the most important of them only:

Leptinidae: Leptinellus validus Horn and *Platypsyllus castoris* Rits. live in the fur of the beaver; the former is to be found only in North America, the latter in Europe and in North America. *Silphopsyllus desmanae* Ols. is an ectoparasite of the desman in Transcaspia.

Staphylinidae: A species belonging to genus *Myotyphlus* lives on *Mus rattus* in Tasmania, while about 10 species of *Amblyopinus* have been recorded in South America as ectoparasites; 4 of them have been found living respectively on *Cavia,* mouse, and opossum, for the others the hosts remain unknown. Finally a species belonging to genus *Edrabius* lives on *Ctenomys* in Chile and *Omaloxenus bequaerti* Notm. on the opossum *(Monodelphis opossum)* in South America.

Scarabaeidae: Canthon quadriguttatus Ol. can sometimes be found in great number in the fur of apes, near their anus, but as PAULIAN (loc. cit.) points it, this beetle can also be found in the apes feces and we are thus dealing here with a case of temporary association. But, on the other hand, several Scarabaeids have been recorded as being regularly found on mammals: *Uroxys gorgon*

[1] We shall restrict ourselves in this paper to beetles living as parasites on mammals and other vertebrates and not mention some entomophagous parasites such as species belonging to genus *Aleochara,* etc.

Arr. and *Trichillum bradyporum* Bouc. are ectoparasites of *Bradypus,* respectively in Colombia and Costa Rica. 6 species of genus *Macropocopris* are parasites of bandicoots and kangaroos in Australia.

The biology of these beetles has been briefly considered by PAULIAN: the Leptinids, the ethology of which is known, live at all their stages on the mammal. They are degenerated but possess no special parasitic adaptation; they are to be found on any part of the body of their host where they may feed on Pediculids and possibly desquamations. The Staphylinids live around the anus of their host, whereas the Scarabaeids are to be found around the latter and also the neck; according to PAULIAN, the larvae must live in feces or organic refuse, on the soil. Genus *Macropocopris* shows an outstanding adaptation to ectoparasitism: the claws of this beetle are cleft from their basis, thus giving a strong hold to the parasite on the hair of its host, the fast moving Kangaroo. But beetles in very rare and odd circumstances can also be found as accidental endoparasites in man and domestic animals.

As regards man, the writer has published a review on the subject (THÉODORIDÈS 1948, 1949 a, 1949 d, HARANT et THÉODORIDÈS 1950); there are numerous cases, some of them would almost be unbelievable if they were not quoted by authorities in Medicine or Coleopterology. The most important are without any doubt the intestinal diseases known as *scarabiasis* and *canthariasis* in which adult beetles in the first case, and their larvae in the second, wander by accident in the human digestive tractus causing pain and all sorts of troubles. The larva of *Tenebrio molitor* L. is responsible for most of the cases of canthariasis (J. LECLERCQ 1948, THÉODORIDÈS 1949 d) whereas Scarabacids of the subfamily *Coprinae* occur frequently in cases of scarabiasis in India and Ceylon. There are other unusual invasions of Coleoptera in the nose, the ear, the eye and even the uro-genital tractus which are however very rare and sporadic.

As regards vertebrates, chiefly domestic animals, there are also cases of accidental parasitism of Coleoptera recorded in the literature (THÉODORIDÈS 1949 b, 1950 a): *Onthophagus granulatus* Boh. has been found perforating the stomach of horses and calves in Queensland, the larva of *Ergates faber* (L.) has been found in the nostrils of a camel in Yemen, larvae of *Tenebrio molitor* L. have been recorded biting chickens to death while those of different species of *Dermestes* and *Necrophorus* frequently attack young pigeons in their nests, burrowing galleries in their skin and thus causing death.

Other Coleoptera of Medical and Veterinary Importance.

Two cases of accidents produced in man by urticating setae of beetle larvae have been recorded in the literature: the first one is mentioned by WELLMAN (1907) in Angola where a species of *Drilus* had urticating larvae causing acute dermatitis in the feet of natives; the other is an account by LOIR and LEGANGNEUX (1922) of a case in which workmen were affected by dermatitis while unloading a ship; this small epidemic was caused by urticating larval and exuvial debris of *Dermestes* and *Necrobia* spp. which were coming from inside the ship and flying around during the unloading. But the most important Coleoptera causing injuries in man are the vesicating species belonging to the *Staphylinidae* and *Meloidae:*

a) *Staphylinidae.*

Several species belonging to genus *Paederus* produce acute vesicular dermatitis or conjunctivitis when crushed on human skin or eyes.

ALLARD (1948) has given a more or less complete account on the subject. The vesicant species are to be found: in South America (*P. columbinus* Lap., *P. amazonicus* Sharp., *P. brasiliensis* Er., *P. irritans* Chap., etc.), in Africa (*P. crebrepunctatus* Epp., *P. sabaeus* Er.), in Asia (*P. fuscipes* Curt., *P. alternans* Walk.), in Europe (*P. fuscipes, P. riparius* L.) (THÉODORIDÈS 1950 b, 1950 c). Most of the above-mentioned species are known to produce local epidemics of dermatitis in the following way: people being in the open air in places where these beetles are to be found (most generally near rivers and damp places) during warm days and especially evenings are surrounded by flying individuals of these insects causing disturbance; they then voluntarily or accidentally crush them on their skin (especially of the face, arms or legs) and are thus liable to dermatitis. These skin injuries are not very serious, but some of the tropical species are more dangerous, thus *P. crebrepunctatus* can produce fever, headache, arthralgia (neuralgic pain in joints) and can leave a scar remaining 8 months. Generally the dermatitis produced by these Staphylinids can be divided into 3 stages:

1. *Erythematous stage:* The skin, one or two days after contact with the beetle shows a red spot or red patches outlining exactly the places where the beetle was crushed; the patient has a tickling sensation and even sometimes feels a serious burn.

2. *Vesicular stage* (hence the name of vesicular dermatitis): After one or two days of the previous stage, small vesicles, the size

of a pin head, appear on the spots; they are filled with a yellowish fluid and may become confluent, thus forming large blisters which break easily, showing a red and very sensitive skin.

3. *Squamous stage:* Skin reparation is achieved in 5 to 8 days; vesicles become flattened and dry and the skin of the affected area peels off gradually. There remains generally a pigmented spot which can stay several months.

As it was said above, several species of *Paederus* can produce eye injuries if crushed near or on it: the East African *P. crebrepunctatus* is thus well known by the natives as causing the "Nairobi-eye", an acute conjunctivitis. There have been numerous experiments made in the laboratory by several workers to reproduce the skin lesions caused by the beetles.

P. fuscipes has been the best studied species in this respect. The dermatitis is produced by a chemical which is found inside the Staphylinids, especially in the blood and the genital organs. This chemical can be dissolved in chloroform, ether, benzine, alcohol, olive oil, but is not very soluble in water. GENEVRAY and co-workers (1934) who extracted this chemical think it is closely related to cantharidin or would be cantharidin itself, but previous authors such as NETOLITZKY (1919) did not agree with this owing to the fact that in the case of *Paederus* spp. there is a latent period between the time of application of the beetle on the skin and the first appearance of irritation, whereas with cantharidin (from Meloids for instance) the vesication is almost immediate.

b) *Meloidae.*

Several genera belonging to this family (*Meloe, Lytta, Epicauta,* etc.) have vesicating properties, this being due to the occurrence in the body of these beetles of a toxical chemical compound: cantharidin ($C_{10} H_{12} O_4$). The skin lesions caused by vesicant Meloids start by a tickling and then burning sensation, very soon after contact with the beetle; afterwards the skin becomes red and hot and large blisters filled with fluid appear. They then dry, a crust is formed and the skin heals in a few days with the formation of a scar. If we glance through the world's present century medical and veterinary literature, we find several species of Meloids which have been mentioned as to their vesicating properties towards man or domestic animals: *Epicauta sapphirina* Maekl. and *E. tomentosa* Maekl. are quoted by CHALMERS and KING (1917) as being a public nuisance at Khartoum (Anglo-Egyptian Sudan), ROMAÑA (1932) relates the vesication produced in Argentina by *Lytta adspersa* Klug., HARRIS (1933) that caused by *Epicauta strangulata* Gerst. in Tanganyika, STEWART (1937) mentions 2 species causing con-

siderable annoyance in the Gold Coast, and finally, more recently, SWARTS and WANAMAHER (1946) have given an interesting account illustrated by very fine photographs of the skin blisters caused by *E. cinerea* Forst. in Arkansas.

There are of course many other cases of skin (or eye) injuries produced by beetles of this family. If Meloids containing cantharidin are accidentally ingested, they can induce very severe intoxication with an intense irritation of the kidneys, urethra and bladder; sometimes death occurs. But as we shall further see in this paper, the external application on the human skin of cantharidin extracted from Meloids has often been used to cure other injuries and this for centuries.

Finally, we must mention some beetles of the family *Oedemeridae* which have been reported these recent years as being vesicant, causing blisters on the human skin with their body fluid: *Xanthochroa atriceps* Lewis, a Japanese species found in Hokkaido and Sakhalin (KONO 1939), species belonging to genus *Eobia* and occurring in south sea islands of Japan, and *Sessinia livida* F., a species which has been found in Hawaii inside army and navy aircraft arriving from outside regions (PEMBERTON 1945).

Coleoptera as Vectors of Pathogenic Bacteria.

Two interesting Russian papers have shown that beetles can spread bacilli which are dangerous for man and animals: OSINSKII (1938) has shown that *Necrophorus vespillo* L., *Silpha obscura* L., *S. atrata* L. *(Silphidae)* can carry the bacilli of anthrax after having been in dead bodies of infested animals, and EKZEMPLYARSKAYA (1941) describes experiments in which tubercle bacilli ingested by larvae and adults, or injected in all the stages of *Tenebrio molitor* persist from stage to stage and remain infective.

Coleoptera as Intermediate Hosts of Helminths.

Many helminthic parasites are heteroxenous, this meaning that their larval stages occur in an animal (intermediate host) and their adult stage in another (final or definitive host). The intermediate host is often an arthropod, and in many cases a beetle; but it would be impossible to give here a complete list of the Coleoptera which can harbour larval stages of helminths, furthermore, this list is far from being complete, and each year new beetles are found to be the so far unknown intermediate hosts (naturally or experimentally) of many helminths.

We shall consider here only beetles harbouring larval helminths

belonging to the most important species affecting man or domestic animals, many of them being also intermediate hosts of parasites living at their adult stage in wild animals less interesting on the veterinary standpoint.

a) *Coleoptera harbouring larval Cestodes.*

Many beetles harbour the larval stages (or cysticercoids) of tapeworms:

Tenebrionidae: Tenebrio molitor L. is an intermediate host of several species belonging to genus *Hymenolepis* having men, rodents or chickens as definitive host (HALL 1929, BRUMPT 1936, BAILEY 1947, J. LECLERCQ 1948, THÉODORIDÈS 1949 d). *Tribolium ferrugineum* F., *Akis spinosa* L., *Scaurus striatus* F. act as intermediate hosts for *H. diminuta. Scarabaeidae:* The dung-beetles living in the feces of domestic animals provide ready intermediate hosts for helminths the eggs of which are expelled in the feces. *Aphodius granarius* (L.) is the intermediate host of *Hymenolepis carioca* (Mag.), (JONES 1929) and *Geotrupes sylvaticus* Panz. (= *stercorosus* [Scriba]) harbours *Choanotaenia infundibulum* Bl., both of these tapeworms being parasites of chickens. The latter of these beetles is also the intermediate host of another species of *Hymenolepis* parasitizing ducks. *Ataenius stercorator* F., *A. cognatus* Lec. and *Choeridium histeroides* Web. are the intermediate hosts of *H. cantaniana,* a tapeworm parasitizing also chickens (JONES and ALICATA 1935).

These are the most important Coleoptera having medical and veterinary importance by enabling the development of tapeworms; but several others, found infected in nature or experimentally fed with gravid segments of the tapeworm, were studied (HORSFALL and JONES 1937, HORSFALL 1938 a, 1938 b); furthermore, as it was stated above, wild mammals (especially rodents) are often parasitized by tapeworms having beetles as intermediate hosts (RENDTORFF 1948).

b) *Coleoptera harbouring larval Nemathelminths.*

Here we have a great number of coleopterous intermediate hosts, far greater than for the tapeworms. Most of the nemas having their larval stages in beetles and being of a medical or veterinary importance belong to the superfamily *Spiruroidea.* These nemas have a life-cycle involving coprophagous arthropods swallowing embryonated eggs; in these hosts the larvae develop, and when the arthropods are eaten by the final host, they reach their adult stage in the latter. In VAN ZWALUWENBURG's very complete report (1928) (but now out of date) we may count no less than 35 species of beetles

being intermediate hosts of Spiruroids, and one year later (HALL 1929), more than 40 species are listed. As for the tapeworms, the most important coleoptera, harbouring larval stages of nemas, are to be found among the *Tenebrionidae* and *Scarabaeidae,* this being easily explained by the saprophagous and coprophagous habits of these 2 families.

Tenebrionidae: Akis goryi (Sol.), in North Africa, is the intermediate host of 2 species of the genera *Spirocerca* and *Spirura* parasites of dogs and cats; 5 species of *Blaps* harbour 3 species of *Spirura* and *Gongylonema* parasitizing rodents, dogs, cats, sheep, cattle and horses; *Tenebrio molitor* harbours only 2 species of Spiruroids parasitizing only rodents, and therefore of little veterinary importance (J. LECLERCQ 1948, THÉODORIDÈS 1949 d).

Scarabaeidae: 9 species of *Aphodius* are the intermediate hosts of 4 species of Spiruroids belonging to genera *Gongylonema, Protospirura* and *Arduenna.* The first two of these nemas are parasites of the same domestic animals as listed above, but *Arduenna strongylina* (Rud.) lives in swine and cows. *Copris hispanus* (L.), *Geotrupes douei* Gory, *Gymnopleurus sturmi* McLeay and 2 species of *Scarabaeus* are in North Africa the intermediate hosts of *Spirocerca sanguinolenta* (Rud.), an important parasite of dogs. In China, this nema is also present and its coleopterous intermediate host belongs to genus *Paragymnopleurus* and not *Canthon* (THÉODORIDÈS 1949 c). Six species of *Onthophagus* are also intermediate hosts of Spiruroids mentioned above and of *Physocephalus sexalatus* (Mol.) a parasite of swine. Finally, several Scarabaeids are the intermediate hosts of *Macracanthorhynchus hirudinaceus* (Pall.), the giant thorn-headed worm of swine, belonging to the order *Acanthocephala* generally classified in the Nemathelminths. These hosts are: *Melolontha melolontha* L., *Strategus julianus* Burm., 3 species of *Phyllophaga, Xyloryctes satyrus* F. (GLASGOW 1926, 1927 a, 1927 b) and *Cotinis nitida* L. (KATES 1943).

Coleoptera or their by-products used as drugs.

Since the beginnings of humanity, some beetles have been used as drugs and some of them are still used nowadays, though to a lesser extent; this is due to the presence of chemicals in the Coleoptera, but it has often been shown that some properties of curing disease ascribed to some of these were only superstitions of the popular mind. The most complete survey of Coleoptera used as drugs has been made by the Austrian coleopterist NETOLITZKY (1919-20); we shall here summarize the essential of his data, keeping the systematic order he followed.

Meloidae.

As we saw above, many genera and species of this family have vesicating properties due to cantharidin. These properties have often been used to develop burns and irritation (revulsive action) in order to cure lung affections, spots or scars of the eye cornea, rheumatism, tooth and ear ache, etc., and to stimulate the growth of hair. Hard rubbing of the sensitive spots with the beetle (generally *Lytta vesicatories* L.) helps to cure chronic skin diseases and badly healing wounds; finally, Meloids have been used as a caustic against the bite of poisonous or rabid animals. Cantharidin has also been taken internally to stimulate the kidneys, and has often been used as an aphrodisiac. But the ingestion of this chemical can be extremely dangerous by poisoning the blood, and NETOLITZKY points out that a single gram of cantharidin is enough to kill nearly 300 humans or to injure badly 5,000!

In ancient times, the vesicating properties of Meloids were already known: the famous Greek physician HIPPOCRATES is reported to have been the first to use *Lydus trimaculatus* F. in medicine, and PLINY mentions in his "Natural History" the different species of *Mylabris* and the irritation caused by them on the skin. Species of Meloids have been used as vesicating agents throughout the world: *Lytta vesicatoria* the well-known "Spanish-fly" in the Mediterranean area, and *L. conspicua* Waterh. in Persia and Afghanistan. Species of *Epicauta* in Europe and America (in Mexico, *E. rufipedes* Dug. were already mentioned in old scripts), species of *Meloe* in Europe, North Africa and North America (*M. angusticollis* Say in Pennsylvania), of *Mylabris* (= *Zonabris*) in the Mediterranean area and Russia. DUTT (1922) has given an account on the species used in India in the drug trade; they are: *L. vesicatoria* (imported from Spain), *Mylabris sidae* F. and *M. phalerata* Pall. (Chinese species) and *M. chicorii* F. The Indian "blister beetles" (the popular name of Meloids) occur chiefly in Gwalior Province which supplies the requirements of the Government Medical Stores Depots. The same author gives details on the way Cantharides are collected for medical purpose and notices that while *L. vesicatoria* yields on an average 0.7% of cantharidin, Indian species yield from 0.7 to 1.92%.

A species from the Murree Hills: *Cantharis* (= *Lytta*) *hirticornis* contains as much as 2.02% of cantharidin [2]. The Cantharides of

[2] It is important to notice here that frogs, hedgehogs and most of the birds are immune to the action of cantharidin, but it can poison men or animals eating them. Cantharidin can be extracted with hydrochloric acid and chloroform, or with ethyl acetate.

Uruguay have been studied by GONZÁLEZ, BARATTINI, and ROMERO (1942): *Epicauta adspersa* Klug (= *conspersa* Curt.) yields 0.43% of catharidin by the method of the French Codex.

We shall not say much about the *Tenebrionids*. NETOLITZKY recalls that fats extracted from *Blaaps, Primelia,* and *Gnaptor* mixed with rose oil were used to cure earache and clean abscesses.

Coccinellids.

In the ancient times lady-birds were used as drugs to cure toothache and even as toothpaste! A recipe from 1560 says that application of a finger on a sensible tooth, after having crushed a lady-beetle with it stops pain immediately; the beetles were also used in alcoholic extract. There may be active substance in the blood of the insect and it might be worthwhile to check this curious property of Coccinellids.

Chrysomelids.

According to NETOLITZKY, several beetles of this family are also efficient against toothache. Among these are: *Melasoma populi* L., the larvae of *Plagiodera versicolor* Laich. and *Phyllodecta vitellinae* L. This property explains the fact that the first of these beetles contains salicyl aldehyde and the 2 others (cf. also WAIN 1943-44) salicylic acid, the acetyl derivative which is part of the composition of aspirin; these chemicals are to be found in the leaves of populars and willows, and the beetles accumulate them by eating these plants.

Curculionids.

Larvae of several species belonging to genera *Rhinocyllus, Lixus, Larinus* and *Rhynchites* seem also to have the property to soothe toothache. GERBI even mentions a *Rhinocyllus antiodontalgicus,* 15 larvae of which crushed and then applied with the moistened finger on the tooth would stop the pain in 15 minutes. As regards genus *Larinus,* PIERCE (1915) reviewed the subject and explained how the cocoons made by the weevils of this genus contain a special sugar, trehalose ($C_{12} H_{22} O_{11}$) used in the East as food and also as a drug; this sugar whose local name is "trehala" is quoted by one author mentioned by PIERCE as "abundant in the shops of the Jew drug-dealers of Constantinople, where it is frequently used by the Arab and Turkish physicians in the form of a decoction which is regarded by them as of a peculiar efficiency in diseases of the respiratory organs." (See also: J. THÉODORIDÈS, Les colloptères comestibles, Nat. Belg. 30, 1949, p. 126-137 1 pl.). Other authors mentioned in the same paper give more details as to the

use of trehala: to obtain the decoction used in diseases of the respiratory organs, especially bronchial catarrh, a litre of boiling water is poured over about 15 grams of cocoons, this is stirred for about a quarter of an hour, then boiled, and drunk by the patient without being filtered.

The use of Curculionids as drugs is also mentioned by WEISS (1947).

As regards other beetle families (*Lucanids, Scarabaeids, Lampyrids*) NETOLITZKY mentions also some medical properties, but most of these seem in fact to exist only in the imagination of folks, so we shall not mention them here.

Coleoptera of medico-legal importance.

It is now well known that necrophagous insects and especially Coleoptera (*Silphids, Histerids, Dermestids, Ptinids,* etc.) give important data in legal medicine as to trace the exact time when death occurred, in case of murders (PESSÔA and LANE 1941, M. LECLERCQ 1949).

Conclusion.

We hope by this short and thus incomplete account to have shown the place which Coleoptera occupy in Parasitology and Medicine and to promote among the readers of this paper already interested in these branches of Biology active participation in this unusual but important aspect of Coleopterology.

Note: I would be very grateful to any one who could give me some unrecorded original informations on some of the various aspects of Coleopterology described in this paper and I will be willing to identify specimens involved in some of these aspects, if any. Please send correspondence on this item to the Editors or directly to my actual address.

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Résumé.

Bien que beaucoup moins importants que les Diptères ou les Hémiptères, les Coléoptères ont cependant un certain rôle en Parasitologie et en Médecine.

Les différents aspects de ce sujet généralement méconnu sont passés en revue ici :

Ce sont tout d'abord les Caléoptères ectoparasites de mammifères (*Leptinides*, certains *Staphylinides* et *Scarabéides*), puis les

cas très curieux où des Coléoptères adultes ou larvaires ont été rencontrés accidentellement chez l'homme et les animaux domestiques.

Sont ensuite considérés les Coléoptères vésicants appartenant aux familles des *Staphylinides (Paederus),* des *Méloïdes (Meloe, Lytta, Epicauta,* etc.*)* et accessoirement des *Œdémérides* ; les lésions occasionnées par ces divers insectes sont sommairement rappelées.

Les Coléoptères vecteurs de bactéries pathogènes sont brièvement mentionnés, et ceux qui sont hôtes intermédiaires d'helminthes sont considérés plus en détail, étant donné leur incontestable importance médicale et vétérinaire.

Le paragraphe qui suit traite des Coléoptères employés dans la pharmacopée dont l'usage tend d'ailleurs à disparaître de nos jours.

Enfin, l'importance des Coléoptères nécrophages et saprophages en Médecine légale est brièvement rappelée.

Zusammenfassung.

In Parasitologie und Medizin spielen die Käfer, wenn auch in viel geringerem Grade als die Dipteren und Hemipteren, eine bedeutende Rolle.

In der vorliegenden Arbeit werden die verschiedenen Seiten dieses vielfach etwas vernachlässigten Problems besprochen: Vorerst die Käfer als Ektoparasiten der Säugetiere (*Leptinidae,* gewisse *Staphylinidae* und *Scarabaeidae*), dann die sonderbaren Fälle, in welchen Käfer in adultem oder larvalem Zustand sowohl auf dem Menschen als auch auf dem Haustier vorkommen.

Darauf werden die zu den Familien der *Staphylinidae* (*Paederus*), *Meloidae* (*Meloe, Lytta, Epicauta* usw.) sowie ausnahmsweise auch der *Oedemeridae* gehörenden Blasenkäfer betrachtet, und es wird an die durch diese Insekten hervorgerufenen Schädigungen erinnert.

Käfer als Träger pathogener Bakterien werden ebenfalls kurz erwähnt. Gründlicher behandelt der Autor jene, welche Zwischenwirte von Würmern sind, in Anbetracht ihrer unbestreitbaren medizinischen und tierärztlichen Bedeutung.

Im folgenden Abschnitt werden Käfer behandelt, welche in der Arzneilehre Verwendung finden, obgleich deren Anwendung heutzutage im Verschwinden ist. Endlich wird auch auf die Bedeutung der Aaskäfer in der Gerichtsmedizin hingewiesen.