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## The entomofauna of the cones of fir (*Abies alba*) in Poland

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In the years 1976-1980 a total of 20 040 individuals belonging to 14 insect species were obtained from cones of fir (*Abies alba*). The material originated from 46 localities in Poland. Coenotic groups of insects were defined. A domination coefficient (D) and a species diversity index (D') were calculated.

Cones of coniferous trees constitute microhabitats with which are associated the representatives of various insect species. Some of them are serious pests of the seeds. So far, special consideration has been given to the entomofauna of spruce cones (*Picea abies*) in Scandinavian countries (TRÄGÅRDH, 1917; HOLSTE, 1922; BAKKE, 1955, 1963) and in the USSR (STADNITZKY, 1969, 1971; SAKSONS, 1973), as well as to the entomofauna of the European larch cones (*Larix decidua*), Polish larch cones (*L. polonica*) (KARPIŃSKI, 1967; SKRZYPCZYŃSKA, 1977), and pine cones (*Pinus* sp.) (SAKSONS, 1973; GAYDENE, 1976). To date the entomofauna of the cones of *Abies alba* has not been investigated and existing foreign publications provide fragmentary data only, which concern *Megastigmus suspectus* BORR. (Hym., Torymidae) (KOZIKOWSKI & KUNTZE, 1936; ESCHERICH, 1939; ČERMAK, 1952; KAPUŚCIŃSKI, 1966; SKRZYPCZYŃSKA, 1978; STADNITZKY *et al.*, 1978), *Resseliella piceae* SEITN. (Dipt., Cecidomyiidae) (SEITNER, 1906; KOZIKOWSKI & KUNTZE, 1936; ČERMAK, 1952; SZMIDT, 1965; and STADNITZKY *et al.*, 1978), *Barbara herri-chiana* OBR. (Lep., Tortricidae) (ESCHERICH, 1931; PATOČKA, 1960) and *Dioryctria abietella* (DEN. et SCHIFF.) (Lep., Phycitidae) (SZMIDT, 1965; STADNITZKY *et al.*, 1978).

The aim of this study was to identify insects from the cones of *Abies alba*, to estimate their number, and to calculate a coefficient of domination and index of diversity of species in fixed coenotic groups.

### METHODS OF INVESTIGATION

Laboratory and field studies were conducted in the years 1976-1980. Material consisted of cone samples of the fir *Abies alba*, collected in the Beskid Sądecki region (46 localities) in Poland. For investigations two types of cones were collected, i. e., ripening cones in July and August and ripe cones from September to late October. A total of 1971 cones were collected from 106 trees, i. e., 14-20 cones per tree. 335 ripening cones (with 92,006 seeds) were dissected. Part of the larvae obtained from these dissections was placed in tubes with 75% ethyl alcohol, part was reared to study parasitism. The remaining ripening cones were partly (about 25%) placed in glass tubes for individual cultures and partly (about 75%) in bottling jars for mass cultures. From the mature cones, 300 seeds were randomly selected (altogether 9,300 seeds) which were subsequently dissected to estimate the degree of infestation. A portion of mature cones, like the maturing ones, were used for

Table 1: Specification of insects in *Abies alba* cones according to orders.

Order	Species		Individuals	
	Number	%	Number	%
Coleoptera	3	21.4	32	0.2
Hymenoptera	3	21.4	1,916	9.6
Lepidoptera	2	14.3	330	1.6
Diptera	6	42.9	17,762	88.6
Total	14	100	20,040	100

individual and mass cultures. Cultures were prepared under laboratory conditions at 18–20 °C and 70–75% rel. humidity. During autumn and winter the cultures were kept at about 4 °C. Hatches of imagines were frequently checked up.

Coenotic groups of insects were given together with the formulae for a domination coefficient (D) (TROJAN, 1975) and a species diversity index (D') (MARGALEF, 1968). The results are presented in tables 1 and 2.

## RESULTS

A total of 20,040 individuals were obtained from cones of *Abies alba*, which represented 14 species belonging to 4 orders, i. e. Diptera (17,762 individuals, or 88.6%), Hymenoptera (1,916 individuals, or 9.6%), Lepidoptera and Coleoptera (relatively scarce) (tab. 1).

Among Diptera the most numerous were the representatives of the family Cecidomyiidae, and in particular those of *Resseliella piceae*: 10,961 individuals from 40 localities. Also strongly represented were the individuals of the family Sciaridae, particularly *Lycoriella cellaris* (LENGERSDORF): 5,393 individuals from 26 localities. Comparatively less numerous proved to be the species *Earomyia impossibile* MORGE (Lonchaeidae) (660 individuals from 30 localities) and *Lestodiplosis ?holstei* KFFR. (Cecidomyiidae) (549 individuals from 12 localities). A few additional specimens of Diptera occurred sporadically.

Among Hymenoptera the most abundant species was *Megastigmus suspectus*: 1,895 individuals from 36 localities. The rest of the specimens of Hymenoptera occurred sporadically. Among the insects obtained, *Platygaster* sp. (Hym., Platygastridae) and *Camptomyia* sp. (Dipt., Cecidomyiidae) seem to be new to science and will be described elsewhere. *E. impossibile* is new to the Polish fauna.

With respect to coenotic conditions the insects listed in tab. 2 can be assigned to the following groups:

- I: conophagous insects whose larvae while feeding devastate the seed scales of cones together with the seeds inside;
- II: seminiphagous insects whose larvae feed inside the seeds;
- III: parasites and predators of conophagous and seminiphagous insects;

Table 2: Specification of dominance indices (D) and species diversities (D') in group relating to the insects in *Abies alba* cones.

No.	Coenotic group	Species	N <sup>1</sup>	D	D'
I	Conophagous insects	<i>Barbara herrichiana</i> OBR. (Lep., Tortricidae) (b)	327	33.030	0.289
		<i>Dioryctria abietella</i> (DEN. et SCHIFF.) (Lep., Phycitidae) (a)	3	0.303	
		<i>Earomyia impossibile</i> MORGE (Dipt., Lonchaeidae) (c)	660	66.667	
II	Seminiphagous insects	<i>Megastigmus suspectus</i> BORR. (Hym., Torymidae) (a)	1,895	14.740	0.095
		<i>Resseliella piceae</i> SEITN. (Dipt., Cecidomyiidae) (c)	10,961	85.260	
III	Parasites and predators of conophagous and seminiphagous insects	<i>Macrocentrus collaris</i> SPIN. (Hym., Braconidae) (a)	3	0.526	0.315
		<i>Platygaster</i> sp. (Hym., Platygasteridae) (a)	18	3.158	
		<i>Lestodiplosis ?holstei</i> KFFR. (Dipt., Cecidomyiidae) (c)	549	96.316	
IV	Saprophagous and coprophagous insects	<i>Lycoriella cellaris</i> (LENGERSDORF) (Dipt., Sciaridae) (c)	5,393	96.441	0.231
		<i>Camptomyia</i> sp. (Dipt., Cecidomyiidae) (a)	192	3.433	
		<i>Drosophila repleta</i> WOLLAST. (Dipt., Drosophilidae) (a)	7	0.126	
V	Seasonal insects	<i>Rhizophagus dispar</i> (PAYK.) (Col., Rhizophagidae) (a)	1	3.125	0.577
		<i>Cryptophagus</i> ( <i>Micrambe</i> ) <i>abietis</i> (PAYK.) (Col., Cryptophagidae) (b)	11	34.375	
		<i>Cartodere filum</i> (AUBE) (Col., Lathridiidae) (c)	20	62.500	

(a) = an accessory species; (b) = an influent species; (c) = a predominant species

<sup>1</sup> = number of individuals

IV: saprophagous and coprophagous insects whose larvae feed on dead organic substance (e. g. imperfect seeds) and on excrements of caterpillars infesting the cones;

V: seasonal insects for which the cone has provided shelter, frequently unexpected.

To estimate the role played by a given species in the distinguished coenotic groups, a domination coefficient (D) was calculated:

$$D = 100 \frac{S_a}{S}$$

where  $S_a$  = total of individuals belong to the species «a» in all the tests performed, and  $S$  = total of individuals within the tested group of species in all tests (TROJAN, 1975).

To compare the composition of species in the established coenotic groups, the MARGALEF's formula (1968) was used to calculate index of diversity ( $D'$ ):

$$D' = (S - 1) / \log_e N$$

where  $S$  = number of species in a group, and  $N$  = number of individuals in a group. The mentioned index had the highest value in the group V (0.577) and the lowest one in the group II (0.095) (tab. 2).

## DISCUSSION

The complex of insects associated with *Abies* cones includes several species which were not obtained during the present study, as for instance *Megastigmus strobilobius* RATZ. (Hym., Torymidae) (PRISYAZHNYUK, 1949), *Eupithecia abietaria* var. *debrumeata* ST. and *E. gigantea* ST. (Lep., Geometridae), *Hyphantidium terebellum* ZINCK. (Lep., Phycitidae), *Lasiomma abietis* HUCK. (Dipt., Anthomyiidae), *Earomyia grusia* MORGE (Dipt., Lonchaeidae) (STADNITZKY *et al.*, 1978) and *E. viridana* (MEIG.) (KOZIKOWSKI & KUNTZE, 1936; MORGE, 1962).

A relatively small number of insect species is observed in the cones of *Abies alba* as compared with that found in the cones of other coniferous trees, e. g., *Picea abies* with 135 species (STADNITZKY, 1969), *Larix decidua* with 71 species and *L. polonica* with 45 species (SKRZYPCZYŃSKA, 1977). This small number of species results from the properties of the fir cones. The mature cones of *A. alba* undergo a process of desintegration on the tree, in contrast with the cones of other coniferous trees, which stay unaffected for a longer period of time.

In the maturing cones and seeds of fir trees under study, the larvae of *Resseliella piceae* were found to be more abundant than those of *Megastigmus suspectus*. *R. piceae* larvae feed on the seed and proved to be a serious pest. Parasitoids of *R. piceae* were observed in small number and in three localities only. *M. suspectus* has been often mentioned as a pest of the *Abies alba* seeds. The analysis of 300 *A. alba* seeds from each locality (altogether 9300 seeds) indicated an average infestation of 2.79% by the larvae of *M. suspectus*.

## CONCLUSIONS

- (1) The number of insect species in the cones of *Abies alba* is relatively small as compared with the number of insect species in the cones of other coniferous trees.
- (2) Most frequently occurring insects were species of Diptera, and among them *Resseliella piceae*.
- (3) *R. piceae* appeared to be a serious pest of fir seeds in contrast to *Megastigmus suspectus*, a pest of local incidence.
- (4) Only three cases of parasitism of *R. piceae* larvae by *Platygaster* sp. would be indicative of a slight resistance of the environment against the mentioned pest.

- (5) During the study period *Earomyia impossibile*, *Barbara herrichiana* and *Dioryctria abietella* were of no economic significance.
- (6) *E. impossibile*, *R. piceae*, *Lestodiplosis ?holstei*, *Lycoriella cellaris* and *Cartodere filum* proved to be predominant species in the relevant coenotic groups; other species seem to be influent or accessory insects.
- (7) Based on diversity index it can be supposed that the group of seasonal insects was most diversified as well as those of parasitoids and predators of conophagous and seminiphagous insects.

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