Prospects of aradidology in the Westpalaearctics

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ABSTRACT After the monograph of USINGER and MATSUDA (1959) a new wave of investigations resulted in the duplication of known species. Most of the new species came from the tropics and most of the papers were merely descriptive. There is a small increase in the number of known palearctic species too, but this is mainly due to a lucky set of interested specialists as well as to more thorough investigations and the use of male genitalia in identification and species separation.

One can assume that modern taxonomic methods can lead to the description of some further species (e.g. the two ecotypes of *Aradus ribauti*). As a consequence of intensive forestry, habitats are disappearing in some areas with subsequent faunal changes. We should investigate the effect of rapid destruction of forests (gradation of *Aradus maculatus* and *A. kuthyi* was found only once in affected forests, otherwise flat bugs were lacking from dead trees). Food plants or fungi are known in a few species only (what are *Calisius* species feeding on? is *Aradus distinctus* bound to *Helianthemum* too?). The only species of which we do have some data on population biology is *Aradus cinnamomeus*. We do not know the bionomy and natural enemies of several species. Postembrional development is known mostly in the western species and that only in specific details. There are only sporadic data on ethology of these peculiar creatures of nature: two types of defense behaviour were observed, probably both unique to Heteroptera.

IZVLEČEK PERSPEKTIVE RAZISKOVANJA ARADID ZAHODNEGA PALEARKTIKA Po monografiji izpred 30 let (USINGER in MATSUDA, 1959) se je število znanih vrst stenic aradid (Aradidae) približno podvojilo. Večina novih vrst je tropskih, večina člankov je le opisnih. Opisanih je tudi nekaj novih palearktičnih vrst, kar lahko pripisujemo resnemu delu nekaj specialistov in uporabi morfoloških znakov genitalij samcev za razlikovanje vrst.

Domnevamo lahko, da bodo sodobne taksonomske metode omogočile opise nekaterih novih vrst (npr. dva ekotipa vrste *Aradus ribauti*). Ugodni habitati ponekod izginjajo zaradi intenzivnega izkoriščanja gozdov, zato se favna spreminja. Raziskovati bi morali učinke hitrega propadanja gozdov (običajno so mrtva drevesa brez aradid, le v dveh primerih smo opazili gradacijo vrst *Aradus bimaculatus* in *A. kuthyi*). Samo za nekaj vrst aradid poznamo hranilne rastline ali glive (s čim se hranijo vrste *Calisius*, ali je tudi *Aradus distinctus* vezan na *Helianthemum*?). Edina vrsta, za katero poznamo populacijsko biologijo, je *Aradus cinnamomeus*. Ne poznamo bionomije in naravnih predatorjev mnogih vrst. Postembrionalni razvoj je poznan predvsem za vrste zahodne hemisfere in le v nekaterih podrobnostih. Imamo samo slučajne podatke o vedenju teh nenavadnih bitij: avtor je opazoval dva tipa obrambnega vedenja, ki sta verjetno edinstvena v skupini Heteroptera.

Flat bugs are highly adapted to the peculiar way of life they live. In a temperate climate most of the species live hidden under the bark of trees, that is one of the reasons why several species are so rare in collections. A problem in investigating them is that by finding and observing them, their habitat is severely disturbed, often with irreversible alterations in the natural conditions. This is why the study of bionomics of flat bugs seems to be a challenge for naturalists and why questions posed in the masterly monograph of USINGER and MATSUDA (1959) still await an answer. Below I give an overlook of some of the prospects of Aradidology in our subregion.

After that 1959 monograph a new wave of investigations resulted in the duplication of known species. Most of the species came from the tropics and most of the papers were merely descriptive. There is an increase in the number of known Palaearctic species too, but the trend of the data suggests a certain saturation, which means that most of the species are described from the territory of the Palaearctic Region. Not more than 10 % of the fauna is expected to be unknown from this area. The increase in the last decades is due to the simultaneous appearance of interested specialists, and to the beginning of investigations on previously not investigated features, foremost being the male external genitalia. Recent investigations by E. Heiss and the author, within the framework of a joint revision of the Palaearctic Aradidae, surprisingly revealed three unknown species, two of Mediterranean and one of Palaearctic distribution, but this does not alter the overall situation.

Modern taxonomic methods are rarely used in Aradid taxonomy in this region. A study was begun on caryology by another scientist. Investigations with the scanning electron microscope are, in general, useful in two ways. They can reveal new or poorly observable morphological characters which can later be used either in identification or in taxonomic work. SEM, on the other hand, provides good experience to enable one to see better with a binocular microscope. My studies with SEM led to a better understanding of higher taxonomy of the family, of postembryonal development and of certain adaptations. The results were similar with investigations on the allometry and allometric growth of flat bugs. There is, nevertheless, a great possibility in Aradid allometrics, since most of the species are described with at least some of the measurements and ratios are also given (length-width ratio of head, pronotum, scutellum, relative length of antennal joints). Some ratios (e. g. l/w of head) are useless in species level taxonomy since they seem to be characteristic in genera, others could, however, help in recognition of species in the Palaearctic too.

With abrupt killing of copulating pairs we might be able to obtain males woth inflated genitalia. According to the drawings of USINGER and MATSUDA (1959) and to investigations on not inflated inner genitalia, aedeagi might show striking shapes and structures. A suitable method to

inflate the genital apparatus of dead males would provide a totally new feature for further taxonomic studies.

Recent decades offer an unexpected task for Aradid faunistics. The distribution of flat bugs seems to change rapidly due to modern forestry and more the effective overcoming of forest fires. The papers of BOSMANS and PÉRICART (1982) and HELIÖVAARA and VAISANEN (1983) gave alarming data for the Northern part of Europe, where several species seemed to disappear. Such data are lacking for the Southern part including the Balkans and adjacent regions. Another very recent change is the rapid destruction of forests due to several factors but probably primarily to acid rains. Dying trees in such forest areas are still standing, but the bark is coming off. One would expect flowering aradid populations here, but wood and bark are dry due to the disturbed circulation of tissue fluids, thus fungi are lacking from such trees. In the course of repeated investigations in Hungary only once and in one place, the gradation of two species (*Aradus bimaculatus* Reuter and *A. kuthyi* Horváth) was found on 30-40 year-old oak trees. The populations disappeared from the forest area within a year. It would be a task of aradid faunistics to follow the effect of both processes on these organisms, and to document the obvious changes of distribution in our century.

The knowledge of morphology of fifth instar larvae is satisfactory in Central Europe, but younger larvae and eggs are hardly known, as well as, for most of the species, the process of development and voltinism. The latter is surely known for *Aradus cinnamomeus* Panzer only: it has a two years life span (three years in the North) with two overlapping generations. According to the literature and my own observations, the other species can be either univoltine or even bivoltine, but nothing is yet proven. According to the recent personal communication of E. Heiss, some of the species should be acyclic.

Forage, feeding also raises some questions. Most species are mycetophagous, they feed on fungi, but a few suck plants. *Aradus cinnamomeus* feeds on pines (also *Pinus nigra*) and related conifers, *A. pallescens* Herrich-Schaeffer and *A. frigidus* Kiritshenko on *Helianthemum*. *Aradus distinctus* Fieber is often found on soil or in soil traps in Hungary, and, on the other hand, the male genitalia of *A. distinctus* show a close relation to that of the aforementioned species. Any attempt, however, to prove its connection with *Helianthemum* or any other plant was unsuccessful (nevertheless I consider it an open question).

The mechanism how Aradids find the proper trees with the suitable fungi during their dispersal flight in May, is unknown. Copulation was described, but we do not know the mechanisms by which males and females find each other, if they are not together in a larger group. Nothing is known about the population dynamics in the broadest sense, and only scarce data are available on parasitoids and predators.

And, finally, there is also much to learn about ethology of flat bugs. Below I give some data about two different mechanisms of behaviour.

The first is rising to their feet if the bugs have fallen on their backs. This is managed by the use of wings in the hemispherical Plataspidae. Aradids are flat but have thick antenna. Thin, brakeable antennae would obviously be disadvantagous under bark, but, on the other hand, they also use the strong antennae to get on their feet. On such occasions they become very strongly concave so that the body is fixed on three points only: the tip of the two antennae and the tip of the abdomen. In this position they either struggle with all the legs or combine this struggling with a sudden ventral movement of one antenna. In this case the body will turn to one side and if one claw reaches something in which it can be hooked, the insect will promptly turn to its normal position.

Defense by scent can be applied individually and also by a group of individuals. The consequently stronger smell of several specimens has a stronger effect on predators or invaders of the subcortical habitat.

Observations on *Aradus* larvae under the binocular microscope revealed a double defense mechanism. The anal tube, which is in fact the 11th segment, can be telescoped out of the anus and is able to eject the droppings, with the result that the insects wouldn't spoil their surroundings in which they are immobile for considerable lengths of time. Attacked larvae first telescope their anal tubes, curl them over the dorsal side and eject a drop of a transparent fluid with the characteristic smell of bugs. They can eject some drops repeatedly in case of continuous disturbance, and only after this do they use the three dorsal scent glands. Now large spots of the abdomen will be wet and the secretion will evaporate quickly. Other larvae, as in the genus *Mezira*, have a different larval scent gland apparatus. Here the first gland is well developed and its two openings are provided with an ejaculating channel and a common evaporative surface surrounding the openings. Not much is known about the scent gland mechanisms in Aneurinae and Calisiinae.

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