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Ecological Notes on Brachodidae of Eastern Europe

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Abstract

Habitat and biological aspects are noted for *Brachodes appendiculata* (Esper) from research conducted mainly in Hungary and Romania. Adults of most *Brachodes* are localized on grass hosts, usually in steppe or other grassland biotopes from Morocco to central Asia. The *Festuca vaginata* plant association of Hungary is the typical habitat for *Brachodes appendiculata*, while the *Festuca-Artemisia* plant association is another one but slightly less preferred by the moths. Adults are active during morning hours in full sunshine ; sedentary females utilize a pheromone to attract males. Possible mimicry association with some *Andrena* bees (Andrenidae) is hypothesized.

The Brachodidae (formerly Atychiidae) comprise only a small family of 96 species worldwide. In Europe there is only one genus, *Brachodes* (formerly *Atychia*), which has usually been placed in Glyphipterigidae in the past (Meyrick, 1913), more rarely as a subfamily of Tineidae (Staudinger and Rebel, 1901), or as a separate family (Hartmann, 1880 ; and others). Ten non-European genera have been added to Brachodidae following recent studies of various genera formerly in Glyphipterigidae, to form an enlarged concept of the family (Heppner, 1979, 1981). As noted elsewhere (Heppner, 1981), Brachodidae have no relationship with Glyphipterigidae but, contrarily, represent the closest relatives of Sesiidae. The family name required changing to Brachodidae due to homonymy of the type-genus *Atychia* (Heppner, 1979).

The biology of Brachodidae is very poorly known. This is surprising for some of the widespread and not altogether too rare species of *Brachodes* from Europe. To date we have only the old literature reports of Heinemann (1870), Hartmann (1880), and Spuler (1910). Fletcher (1914, 1933) reported on the biology and immature stages of *Phycodes* in India, but this genus is part of the subfamily Phycodinae which probably are all leaf-feeders whereas Brachodinae may all be borers. Data on the immature stages of *Miscera* from Chile and *Sagalassa* from Colombia, both in Brachodinae, are also known (Heppner, 1981) but *Brachodes* have

not been reared since the time of Heinemann. This lack of information is unfortunate, since although the larval and pupal evidence from *Miscera* and *Sagalassa* shows the relationship to Sesiidae noted above, we do not yet have actual verification of this for *Brachodes*. Lederer (1853) did note that pupae of *Brachodes* (field collected) resemble sesiid pupae. The best available taxonomic treatments for some of the *Brachodes* species are the works by Buszko and Sliwinski (1978), for Poland, and Zagulajev (1978), for western Russia. Morphological details have been described by Heppner (1981) and Razowski (1981).

This preliminary paper reports on the habitat, possible mimicry complexes, and some adult biology of *Brachodes appendiculata* (Esper). Field investigations for this report were conducted in eastern Europe in June, 1980, and by Dr. L. Gozmany (National Museum of Natural History, Budapest) in Hungary in 1982. The field studies thus far have not resulted in the discovery of any immature stages of *Brachodes* and Heinemann (1870) evidently remains the only person to have recorded the rearing of *B. appendiculata* but no specimens of the immature stages have been preserved as far as is known.

Ecology and Host Plant Relationships

Brachodes moths comprise 32 species distributed primarily from Morocco to central Asia (Fig. 1). One species occurs in northern India and 3 species occur in South Africa but their exact affinity to other *Brachodes* requires further study. The habitat of *Brachodes* involves steppe and grassland regions where *Festuca* grasses grow in abundance. Thus far only one genus of grass is known to include the host plants of some species of the moths. Most *Brachodes* are found in the Mediterranean mattoral (= chaparral ; or maquis and garrigue) biotope and in more arid regions. *Brachodes appendiculata* is known from as far north as southern Germany and Poland, thus the moths must also be found in forest meadows wherever the host plants grow. Published literature reports all appear to refer back to the original presumed rearing of Heinemann (1870). Larvae are noted as resembling Sesiidae larvae, are root borers of *Festuca* grasses, and have a two-year development cycle. Lederer (1853) found a pupal shell emergent from a grass clump, with the adult resting nearby. Hartmann (1880) noted the larvae on roots of *Festuca ovina* (Linnaeus), in subterranean silken tubes. This larval behavior is similar to that found in the more primitive Sesiidae, the subfamily Tinthiinae, notably the genus *Zenodoxus*. In Hungary, Dr. Gozmany has found the adults on *Festuca vaginata* Waldst. and Kit. *Festuca* grasses are widespread throughout Europe and Asia. Thus, any concentration of such

grasses, possibly of several species, could be used by *Brachodes* larvae. As far as is known the species of *Brachodes* are strictly univoltine, with adults active from April to early July, depending on the climate in their locality (e. g., April in Morocco and Spain ; June-July in central Asia).

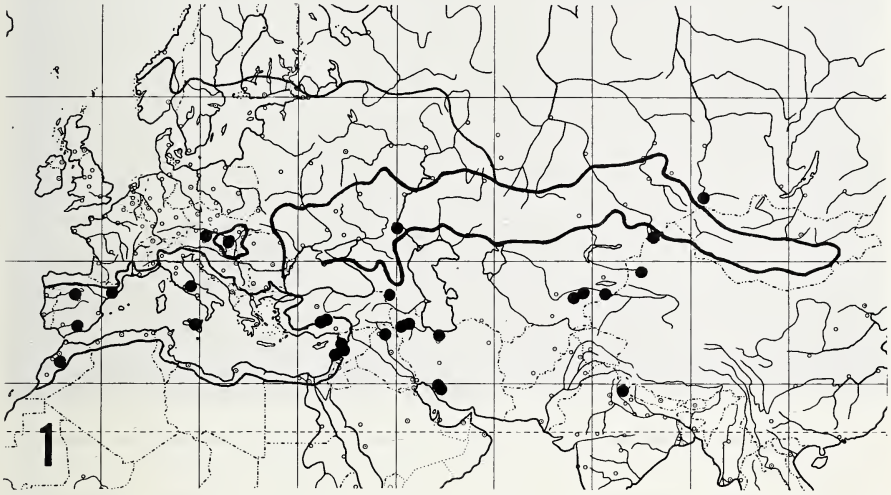

Fig. 1. Distribution map of Palearctic *Brachodes* species by type locality of described species. Heavy enclosing line represents the approximate borders of steppe ; light upper line is the approximate northern limit of broadleaf deciduous forest ; light lower lines indicate the approximate limits of the Mediterranean shrub zone or mattoral (reduced in North Africa).

Habitats were studied in Bulgaria, Hungary, Romania, and Yugoslavia, but efforts were concentrated in Hungary and Romania. In Hungary field studies were conducted at the Kiskunság National Park, Apajpuszta, about 50 km southeast of Budapest. This area (Fig. 2) comprises approximately 11,000 hectares of essentially original Hungarian steppe, or puszta, with light sheep grazing to maintain grasslands. The entire park also includes other habitat types found in the Hungarian Plain, including sand hills and marshy areas, for a total of over 38,000 hectares. The sand hills should be specifically noted here, since they are the only non-coastal sand dunes in central Europe (ranging into Yugoslavia and Romania in the Danube basin). The Hungarian puszta is secondary steppe due to Neolithic interference by man. The original post-glacial vegetation probably was an open oak woodland, except for more open areas in the alkaline plains like Apajpuszta (Horvat et al., 1974). There are various plant associations

Fig. 2. Apajpuszta, Kiskunság National Park, 5 km north of Kunszentmiklos, Hungary.

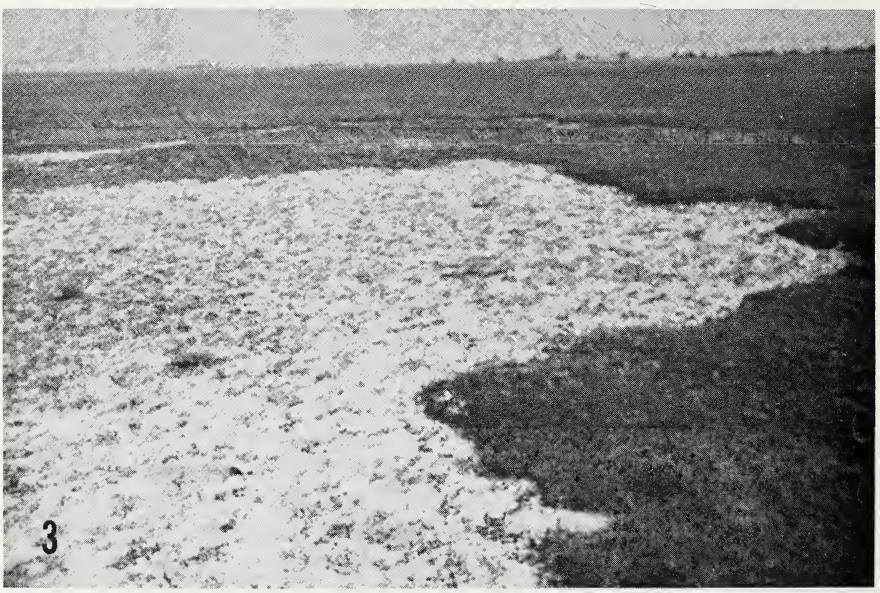

Fig. 3. Natron flat on Apajpuszta, Hungary.

mixed into what appears to be a relatively uniform steppe. There also are occasional clumps of mixed oak forests on small areas of higher and richer soil ; this supports the view that the Hungarian puszta is more specifically a forest-steppe (Horvat et al., 1974). The Apajpuszta area is noted as a sodic puszta, containing small alkaline depressions interspersed among larger grass areas (Fig. 3). These alkaline areas are referred to as "szik" in Hungary, or natron flats.

In Romania, field studies were conducted at the small David Valley Nature Reserve, on the outskirts of the Moldavian city of Iasi. This reserve (Fig. 5) involves only one small hillside with a secondary growth of native grasses and wild flowers among an area of extensive agriculture. The reserve comprises only about 100 hectares. *Brachodes* are known residents of the nature reserves in Hungary and Romania.

The Hungarian puszta is perhaps a typical example of the steppe or other grassland biotope favored by many *Brachodes*, as far as is known, although the moths may actually prefer slight hillsides on the periphery of steppes. The Apajpuszta shows even some areas with pure *Festuca pseudovina* Hackel-*Artemisia maritima* (Linnaeus) plant associations typical of some Aralo-Caspian steppes. The *Festuca-Artemisia* plant association (Fig. 4) found in parts of the David Valley Nature Reserve, Romania, resembles the Hungarian one but has aspects unique to itself as well. It is likely that *Brachodes* are most prevalent in this type of plant association, since *Artemisia* is typical of the more arid regions such as in central Asia and Iran. In June 1980 no adults were found, possibly due to a record cold spring in Hungary. In 1982, on the other hand, *B. appendiculata* were reported to be common from Czechoslovakia to the Danube delta in Romania (Povolny, pers. comm.). Also in 1982 Dr. Gozmany was shown a *Festuca vaginata* dune area at Oisa, near Budapest, by a high school student who had collected *B. appendiculata* adults there. It is thought that *Brachodes* may have a somewhat higher preference for the *Festuca vaginata* plant association than the more saline *Festuca-Artemisia* plant association (Gozmany, pers. comm.).

The climatic regime in Hungary and parts of Romania is typically that of central Europe, with continental cold winters and warm summers. On the Hungarian puszta one finds a more severe summer microclimate, however, than is generally prevalent in forested regions of central Europe, since the combination of open steppe and soda flats produces often relatively high surface temperatures during the summer. On the other hand, the *Festuca-Artemisia* plant association typically shows a very dark ground cover of mosses that may help in warming the subsurface ground during early spring. Average temperatures for the Hungarian puszta are

Fig. 4. *Festuca-Artemisia* plant association on Apajpuszta, Hungary.

Fig. 5. David Valley Nature Reserve, 9 km west of Iasi, Moldavia, Romania.

22°C in July and − 2°C in January (Horvat et al., 1974). Recorded maximum and minimum extremes are about 39°C and − 28°C, respectively. Moldavian Romania has similar temperatures. Heavy spring rains can inundate large tracts of the puszta with several centimeters or more of water for extended periods, followed by strong dessication after a period of cloudless days. Rainfall in Hungary and the Moldavian part of Romania is about 550 mm per year. However, the yearly rain pattern also varies considerably from year to year and the normal intermittent spring to early summer rains may be lacking one year, giving a severe drought, or be too extensive another year, giving a very wet summer. Thus, the subterranean *Brachodes* larvae must experience considerable stress under such variable conditions. Dr. Gozmany is of the opinion that the first winter may be spent in egg diapause, followed by larval development during the first summer. The second winter may then be spent in larval or pupal diapause, with adult eclosion by late May to mid-June. Thus far this is only speculative but inasmuch as the weather is relatively variable and the small host plant roots would force the larvae to move from plant to plant, a two-year cycle of this kind may be flexible enough to be the most adaptive strategy for survival. Similar strategies have been recorded in other Lepidoptera ; e. g., the arid zone adaptations of *Papilio alexanor* Esper via prolonged pupal diapause (Nakamura and Ae, 1977). Likewise, it is possible that from each larval clutch pupae develop that have differential diapause regimens and, thus, may produce adults over a period of several years to meet the vicissitudes of a variable climate, but this remains to be proven. Such pupal diapause variations, however, are known among the Lepidoptera (Prentiss, 1976).

Adult Behavior

The following notes on the adult behavior of *B. appendiculata* have kindly been made available for this report by Dr. L. Gozmany, following his investigations of a colony of the moths found near Budapest, as noted earlier. Adult activity was found to be restricted to the morning hours, primarily 0900 to 1200. Literature reports in the past have tended to suggest a crepuscular diel periodicity for the adults (Spuler, 1910), although some adults of a species in Spain, *Brachodes cassandrella* (Staudinger), have been attracted to lights (Sattler, pers. comm.). Lederer (1853) noted adult flight in full sunshine. A morning activity regime is consistent with what is found among most Sesiidae. Full sunshine was noted to be required for adult activity in *B. appendiculata*, with any period of cloudiness resulting in the cessation of activity. Such morning activity is adaptive to the puszta, since by mid-afternoon the temperature in full

sunshine often become oppressively high during early summer. Females are relatively sedentary while males are very mobile. The female climbs to the tops of the *Festuca* host, turns around to face down and extrudes the ovipositor, moving the ovipositor in circles and occasionally retracting it. It is presumed that pheromones are released in this way, since after about 1 hour males were observed in the vicinity of the females. This behavioral dichotomy between sedentary females and active males is very much the same as among sesiids. During the field observations of 1980 sesiid pheromone was taken into the field to see if any *Brachodes* might respond, however, no males were attracted to sesiid pheromone. *Brachodes* may, thus, be using another formula of pheromone, yet the experiment needs to be attempted again when males are actually verified in the area. Once males are near females, mating was observed very quickly thereafter (Fig. 6). After copulation the females became more active and were observed to begin flying about. No oviposition has been observed thus far, however.

Fig. 6. Mating of *Brachodes appendiculata* (Esper).

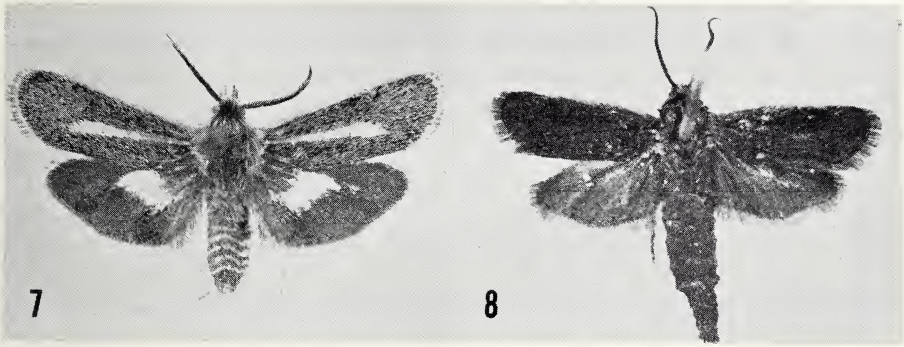

Fig. 7-8. *Brachodes appendiculata* (ESPER), Hungary : 7, male ; 8, female.

Fig. 9-11. Wild andrenid bees from Apajpuszta, Hungary, as possible models for *Brachodes appendiculata* males and females : 9, *Andrena carbonaria* (LINNAEUS) ; 10, *A. limata* EVERS ; 11, *A. chrysopyga* SCHENK.

It is not known for certain if adult *B. appendiculata* moths are involved in any mimicry complex, but the presence of certain andrenid bees in the same plant association on the puszta indicates that this may be possible. Among the *Festuca* and *Artemisia* plants are various wild flowers, *Thymus* being especially popular with various nectar feeders, and these and other flowers undoubtedly must be a source of food for adult *Brachodes* as well. Figures 7-8 show examples of the male and female *B.*

appendiculata moths and figures 9-11 show three possible bee models that occur in Apajpuszta : *Andrena carbonaria* (Linnaeus), *Andrena limata* Evers, and *Andrena chrysopyga* Schenk. At least two of these bees are widespread over much of Europe.

The dark coloration of the females also lends itself to cryptic coloration as a camouflage when resting on a host plant. This is apparent in Fig. 4, which shows the very dark moss substrate covering common to the *Festuca-Artemisia* plant association on Apajpuszta.

Zusammenfassung

Die Brachodidae sind eine kleine Familie von 96 Arten, weltweit (aber nicht in Nord-Amerika) verbreitet, und mit nur 32 Arten in der meist palaearktischen Gattung *Brachodes* (früher *Atychia*). Das typische Biotop von *Brachodes* ist die *Festuca*-Steppe und ähnliche Grassländer, von Marokko bis Zentral-Asien und nördlich in West-Europa bis die südlichen Gebiete von Deutschland und Polen. Es ist zur heutigen Zeit vermutet, nach Untersuchungen der Raupen und Puppen anderer Gattungen (*Miscera* und *Sagalassa*), dass die Brachodidae sehr nahe Verwandten der Familie Sesiidae sind. Nach einer wissenschaftlichen Reise nach Ost-Europa in 1980, und dazu einigen biologischen Notizen von Dr. L. Gozmàny (Ungarisches Naturhistorisches Museum, Budapest) von 1982, wird hier ein Überblick der Ökologie und Biologie von *Brachodes appendiculata* (Esper) als Beispiel der Lebensarten der Familie Brachodidae gegeben. Die Untersuchungen in Steppenländer wurden auf der Apajpuszta, Kiskunság Nationalpark, Ungarn, und in der Davidtal Natur-Reservation, Iasi, Rumänien, gemacht. Die Raupen von *B. appendiculata* mögen eventuell, nach älteren Literaturnotizen, zweijährige Raupen sein, und zwar als Wurzelbohrer in verschiedenen Arten von *Festuca*-Gräsern. Einer der Biotopen der Falter ist wohl die *Festuca-Artemisia* Pflanzenassoziation, wie bei Apajpuszta und in anderen noch trockeneren Gebieten von Zentral-Asien. Das Klima der Steppen ist sehr verschieden, desgleichen die Temperaturen und das Regenregime, und deshalb ist es möglich, dass *Brachodes*-Arten eine Puppendauerpause haben. Meistens sind die Falter in Juni und Juli in Ungarn und Rumanien zu finden, aber es kann sein dass sie in verschiedenen Jahresgenerationen auftreten. Sehr ähnlich wie bei den Sesiiden, zeigen die Weibchen nur wenig Aktivität, sie warten von 0900 bis 1200 Uhr auf die Männchen – welche sie wahrscheinlich durch Pheromonen finden – und bleiben meistens auf der Futterpflanze der Raupen im selben Bezirk, wahrscheinlich als kleine Kolonien. Durch Ähnlichkeit von *B. appendiculata* mit drei Bienenarten der Familie Andrenidae ist es möglich, dass die Falter diese Bienen als Modell in einem Mimikry-Komplex nehmen.

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