# Sound-Production in Netherland Lycaenidae

by

J. C. DOWNEY

*Southern Illinois University, Carbondale, Illinois, U.S.A.*

One of the greatest rewards in rearing insects is the wealth of ecological and behavioral data that may be obtained. Studies on sound-production in lycaenid pupae provide us with an excellent example. Tiny "creaking" or "chirping" noises were first heard in the laboratory when several pupae of *Lycaena thoe* Guer. being reared for other purposes were placed in a single vial. Subsequently we found that at least ten other researchers had heard these sounds from various lycaenid pupae in lab situations, but that the records were well hidden in the vast literature on Lepidoptera. Why knowledge of this behavior is not more generally known is a question, since it has been reported earlier, and some of the common species which make sound have been reared repeatedly. However, the sounds produced are rather subtle and pupae of most species must be placed in containers, which serve as reflecting devices to make the sound more audible. As we reared additional specimens we were able to associate the sound with very rapid movements of abdominal segments posterior to segment five. In many lycaenids there is a very apparent intersegmental cleft or infolded region between abdominal segments five and six (see Plate 1, Figure 1). Slide preparations of the integument in this area of the pupa disclosed the microscopic sound producing organs. These are drawn schematically on Plate 1, Figure 2. A detailed account of the structure of these stridulating organs has recently been given (DOWNEY, 1966) and will not be repeated here. Basically, a posterior file containing numerous teeth is rubbed rapidly across an anterior stridulating plate. The latter is a roughened surface which varies with the species, but which may consist of ridges, tubercles or a grainy texture much like leather.

Having thus associated movements of the living pupa with definite noise producing structures, it was then possible to examine a dried cast pupal skin and make a judgment whether or not sound could be produced by the living pupa. The noise produced by most pupae is not sufficiently loud to enable the original observations, or the subsequent relationship between movement and sound production, to have been discovered by work under field situations. The discovery of this interesting behavior had to be by means of continuous laboratory observation and rearing.

Table 1 is a list of the Lycaenidae from The Netherlands with sound-producing pupae. Also indicated is whether the sound was actually heard or only the stridulatory organs observed. It may be noted that, although sound has been heard in only five of the twentyfour species, the organs have been noted in thirteen others and very likely will eventually be observed in all lycaenids from this country. I have found only four species (out of 108 examined) which seem to lack this ability. These belong to the genera *Glaucopsyche* and *Philotes.* Discovery of the organs in the Netherlands genus *Maculinea* is very significant because of the tribal association of the three genera based on adult taxonomy. The life cycle and complex association of *Maculinea* with ants, as well as its possessing structures for

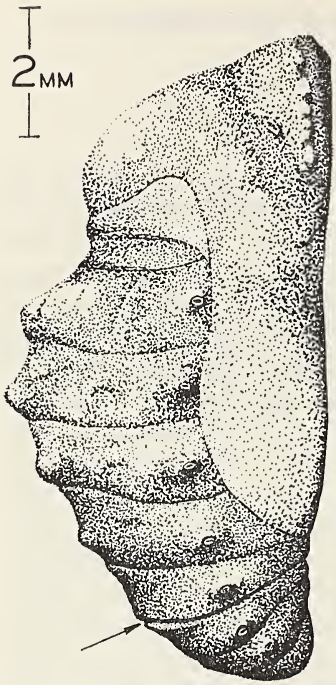


Figure 1. A lateral view of the pupa of *Strymonidia pruni* Linn. The arrow points to the rather prominent dorsal intersegmental cleft between abdominal segments five and six, where movement is possible. The structures which produce sound are located in this area.

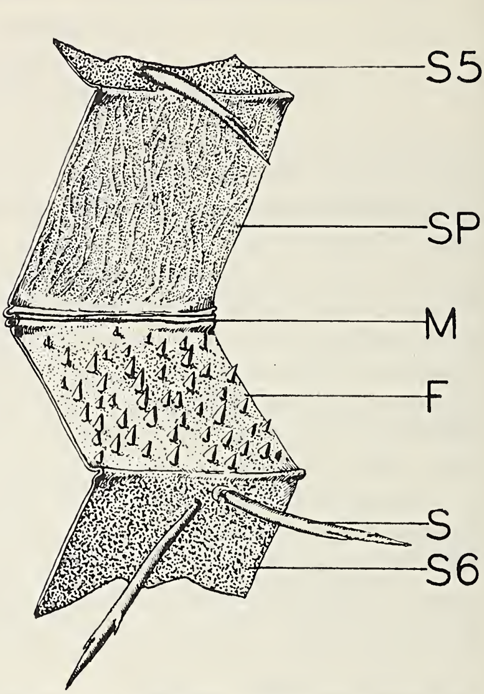


Figure 2. A partially diagrammatic view of a small section of the pupal integument showing the sound-producing organs. Segments five (S5) and six (S6) have been separated so that the file (F) is no longer in contact with the stridulating plate (SP). The region of membranous folds (M) lies between the grating surfaces. The setae (S) are on the part of the segments which are exposed.

pupal sound, strongly suggests a wider taxonomic separation of the above genera.

The pupa of *M. alcon* reared by ELFFERICH in the laboratory had stridulating devices between abdominal segments 3—4 and 4—5 as well as the more universal location between 5—6. *M. teleius* had prominent teeth on the intersegmental regions of the other segments, but only between 5 and 6 could a very distinctive stridulating plate be recognized. All the other species examined from The Netherlands had the typical organs on the intersegmental membrane between segments five and six only. The organs are restricted to the dorsal part of the pupae, between the spiracles.

Although we can presently say much about h o w the pupal stages make noise, we are left to speculate as to w h y this is done. Laboratory rearings may provide that clue. In the past, many writers have assumed that sound production in immature insects has a "defensive" function. However, very rigorous experimentation is necessary to really demonstrate this category of acoustic behavior. In most cases we know very little about other kinds of organisms which are ecologically intimate with the pupal stages — including those which the sound is "supposed" to deter.

Table 1. Netherland Lycaenidae with sound producing pupae

| Species | Sound Heard | Sound Organs Observed |
|---|---|---|
| *Chrysophanus tityrus* Poda | ELFFERICH, new. | — |
| *Lycaena phlaeas* L. | ELFFERICH, new. | ++ |
| *Thersamonia dispar* Haw. | — | ++ |
| *Palaeochrysophanus hippothoe* L. | — | ++ |
| *Everes argiades* Pallas | — | ++ |
| *Cupido minimus* Fues. | — | ++ |
| *Celastrina argiolus* L. | — | ++ |
| *Maculinea alcon* Schiff. | — | ++ |
| *M. teleius* Bergstr. | — | ++ |
| *M. nausithous* Bergstr. | — | — |
| *M. arion* L. | — | — |
| *Lycaeides idas* L. | — | — |
| *Plebejus argus* L. | — | ++ |
| *Aricia agestis* Schiff. | — | ++ |
| *Vacciniina optilete* Knoch | — | — |
| *Cyaniris semiargus* Rott. | — | ++ |
| *Polyommatus icarus* Rott. | — | ++ |
| *Lysandra coridon* Poda | — | ++ |
| *Thecla betulae* L. | — | — |
| *Quercusia quercus* L. | PRELL, 1913 | — |
| *Strymonidia ilicis* Esp. | — | — |
| *S. w-album* Knoch | CARTER, 1952 | ++ |
| *S. pruni* L. | — | ++ |
| *Callophrys rubi* L. | KLEEMANN, 1774 | ++ |

For example, the predators and parasites of the immature stages of Lycaenidae are little known. Only about one percent (137 species) of the Lycaenidae in the world have had identified parasites reported from them. These parasites include about 102 species of Hymenoptera and 41 species of Diptera. One might have erroneously assumed that at least the parasites would be fairly well known since they are often reared with the host and hence must be observed in the laboratory. Of course, comparative data on the rate of parasitism is also lacking. Certainly workers who rear Lycaenidae can add, not only many new records of the parasites, but also extremely interesting data on the relationships between the two organisms.

As expected, we know considerably less about the behavior of the parasites than their identity. So, for example, does sound really protect the pupa from a parasite? Does it interrupt the pattern of innate behavior of the parasite as it attempts to oviposit? We are told that there is an elaborate system of behavior patterns in certain parasites, as well as proper responses in the host organism, necessary to achieve success. Perhaps sporadic and irregular sound given off unexpectedly from a pupa might interrupt this sequence or at least delay it sufficiently long that other factors in the environment might have an increased chance of similar interference. We could further assume that such a delay might not be beneficial to the individual host, but, by increasing the length of time on one host, restrict the number of hosts a parasite could visit during its life.

Although it might be useless to speculate, data on each of these aspects can only be gathered by naturalists who rear the animals with at least a partial cognizance of the kinds of data which may be meaningful.

Other explanations of the function of pupal sound besides defense are certainly possible. We are of the opinion that the relationship of lycaenid larvae and pupae to ants has something to do with the function. As is well known, the larvae of many lycaenid species are tended by ants. There are many reasons for assuming this myrmecophily to be ancestral in the group, and to have evolved independently in several lineages. We likewise assume that the pupal stages were primitively associated with ants. Many species still retain a functional exudate gland (or the scars thereof), and are actively tended by ants. Sound-making ability has also been noted in many ant subfamilies. Recent studies suggest that chemical (pheromones), visual and tactile signals are also involved in the social behavior of ants. However, knowledge of the noises emitted by ants, particularly when at a food source, certainly suggests that sound may be involved in their communication, and they c o u l d react to noises given off by the pupae. Without belaboring the point further, the larval stage of the butterfly has several methods available to either attract or repel ants. The relatively inactive pupae on the other hand, if they were to derive any benefit from myrmecophily, might have fewer avenues of responses to this association, and sound production could be one such route to augment symbiosis.

Of the species in Table 1, only *Vacciniina optilete* seems not to be associated with ants. Although rarity of the species may have precluded observations on this association, it would be very interesting to see if the pupal stages produce sound or possess the stridulating organs.

Whatever be their present function, the almost universal occurrence of sound organs in lycaenid pupae together with the world-wide distribution of the character, suggests that pupal sound production is also ancestral in the family. Species who have lost the structures or modified or lost the basic function (whatever it may have been) have acquired these traits secondarily.

Thus the sound production may have originally developed for, or functioned in, the symbiotic association between ants and pupae. It may then have achieved some value as a protective device against parasites and predators. If sound was extremely effective in this regard we would expect the larvae, who are certainly exposed to a higher rate of parasitism, to have developed this ability. The fact that they haven't may be indicative of the fact that sound is not a good deterrent and the primary function in the origin of pupal sound was not protective. At any rate, as some species lost myrmecophily, sound may have been retained with the selective advantage being for a different purpose. Pleiotropy (a genetic tie with other needed characters) may be used to explain the presence of the sound in some pupae whose immature stages are not tolerated by ants, for example, in the Nearctic *Feniseca*, a carnivore on aphids.

Again these points seem worthwhile to mention only to show certain speculations which need much laboratory work. Students of lepidoptera, regardless of their professional training and background, may provide much significant data while rearing even the most common butterflies.

## Acknowledgments

I am very much indebted to N. W. ELFFERICH of Rotterdam, and Hans MALICKY of Vienna for providing the specimens on which this report is based. Grateful acknowledgment is also made to the National Science Foundation (grant no. GB 2423) which is supporting a project on immature Lycaenidae of which this study is a part.



## Samenvatting

Van de 24 Nederlandse Lycaenidae-soorten werden 16 poppen onderzocht op de aanwezigheid van organen voor geluidsproductie. Deze bleken bij alle 16 soorten aanwezig te zijn. De organen bevinden zich aan de rugzijde van de pop, in de plooi tussen de segmenten vijf en zes. Bij *Maculinea alcon* bevinden zich bovendien tussen de segmenten 3—4 en 4—5 soortgelijke organen. Het geluid ontstaat doordat tandjes snel over de aan de voorzijde gelegen ruwe sjirpplaat gewreven worden. Slechts bij vier soorten die behoren tot de genera *Glaucopsyche* en *Philotes* ontbreken de geluidsorganen. Mogelijk kunnen deze organen gebruikt worden als systematisch kenmerk voor de verschillende genera. Het orgaan is bij de soms zeer verschillende Lycaenidae-poppen over de gehele wereld verbreid. Dit suggereert, dat de geluidsproductie een primitief kenmerk is. Verder wordt verondersteld, dat de geluidsfunctie oorspronkelijk verband hield met de relatie van de poppen met mieren. In diverse Lycaenidae-groepen kan het zich onafhankelijk in een orgaan met een beschermende functie veranderd hebben.


### Literature cited


CARTER, W. A. C., 1952, Notes and observations. *Ent. Rec. and Journ. of Variation* 64 : 255.

DOWNEY, John C., 1966, Sound production in pupae of Lycaenidae. *Journ. Lepidopterists' Soc.* 20 : 129—155.

KLEEMANN, C. F. C., 1774, Beiträge zur Natur- und Insektengeschichte, 4 : 123 (taken from PRELL, 1913).

PRELL, H., 1913, Über zirpende Schmetterlingspuppen. *Biol. Zentralb.* 33 : 496—501.


**Rupsen van Phigalia pilosaria Schiff. (pedaria F.) op Berberis.** Bij toeval vond ik bij Wassenaar op *Berberis* een klein rupsje van een halve cm lengte, dat me onmiddellijk deed denken aan de rups van *Coenotephria sagittata.* Ik dacht dus meteen aan *berberata.* Na veel zoeken vond ik een 50-tal, uitsluitend op de bloemknoppen. Toen ze groter werden, waren het „bruinachtige, bultige rupsen", de enige beschrijving, die ik had van *berberata.* Uiteindelijk werden ze me wat te groot. Ik ben toen op dezelfde plaats nog eens gaan zoeken en kloppen op alle mogelijke struiken. Resultaat: geen enkele rups van eik, beuk of iets dergelijks, alleen van *Berberis.*

Het bleken tenslotte helemaal geen rupsen van *berberata* te zijn, maar van *pilosaria*!

M. W. CAMPING, Julianalaan 37, Putten-Gdl.

**Aangeboden ter overname.** Catalogus Nederl. Macrolepidoptera, deel V tot en met X (V, VI en VII zijn reeds jaren lang uitverkocht). Binnen een week geen antwoord, dan verkocht.

J. J. MEURER, Prinses Irenelaan 43, Hillegom.