

## The tymbal organs of the Lymantriidae (Lepidoptera)

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### Summary

Structures, resembling tymbal organs of Arctiidae and certain Pyralidae, are reported for the first time in certain Lymantriidae. They occur on each side of the third abdominal sternite of the males. The presence of microtymbals, in the male only, suggests that the moths can produce vibrations and that the organs may have a function in mating behaviour.

Absence and presence occur sometimes in species belonging to the same genus and in very unrelated groups within the family, suggesting that the tymbal organs are easily lost in the course of evolution.

### Introduction

In Lepidoptera stridulatory or tymbal organs are only known from three families : many species of Arctiids and Ctenuchids and a Pyralid.

In many Arctiids and Ctenuchids, the tymbal organs are a kind of blister that occupy most of the metathorax above the coxae, their structure is discussed at length by BLEST *et al.* (1963) and some excellent photographs are published in WATSON (1975). Sound is produced by the action of a muscle distorting the entire tymbal organ resulting in a serial buckling of a long row of parallel horizontal striae, each striation acting as a microtymbal. This produces a series of clicks resulting in a cycle of modulation which can be heard in some species (cf. BLEST, 1964).

The sound produced by pyralids has been investigated by SPANGLER *et al.* (1984). In the males of the wax moth *Achroia grisella* (FABRICIUS), vibrations are produced by the tegulae during wing fanning. A portion of the tegulae, coupled to the wings by dorsal and ventral processes, is expanded during the wingstrokes. A pulse of sound is produced during each upstroke and each downstroke of each wing, but its frequency is in the range of 75 to 130 kHz with a maximum sound intensity of 90 bD at 1 cm and thus inaudible to humans.

Recently Mr. D. T. GOODGER, British Museum (Natural History) discovered a pocket-like structure on each side of the 3rd sternite in some genitalia

preparations of Lymantriidae. Those structures, figured for the first time by HOLLOWAY (1986, 1987) are morphologically similar to those of the Arctiidae as figured by WATSON (1975). If they prove to be sound producing, the Lymantriidae would be the fourth family of Lepidoptera to possess tymbal organs.

## Description of the tymbal organs of the Lymantriidae

The tymbal organs of the Lymantriidae are only present in the males.

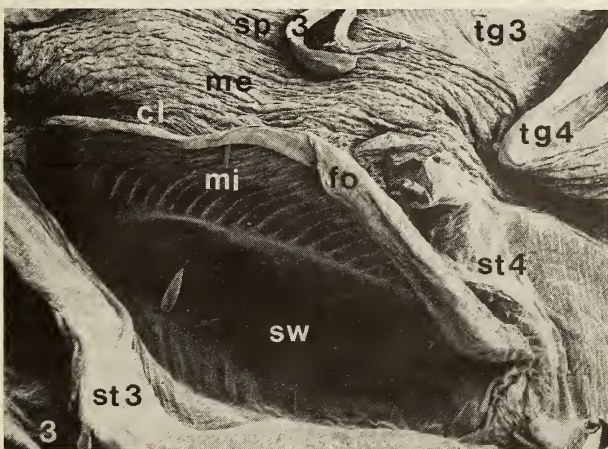
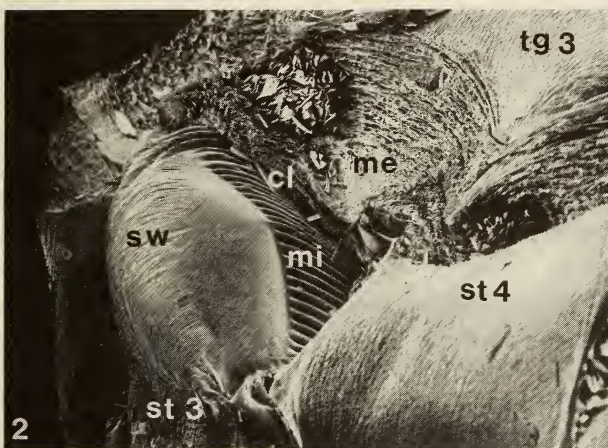
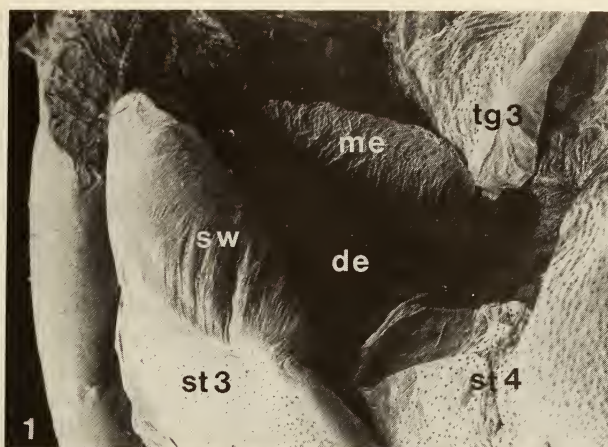
APPEARANCE "DRY" (Figs 1, 2 and 3) : The tymbal organs are nearly always covered with scales and difficult to perceive without brushing these away. They consist of a swelling (sw) on each side of the dorso-lateral parts of the 3rd sternite. These swellings are oblique, and their dorsal parts protrude into the abdomen under the dorso-ventral membranes. Usually the part of the sternite opposite to the swelling is also curved inward and forms subtriangular depressions (de) as in *Lymantria monacha* (L.) (Fig. 1) but sometimes this part remains straight forming oblique clefts (cl) as in *Olapa* (Fig. 2). These depressions or clefts protrude inside the abdomen forming folds (fo), (Fig. 3). The inner part of these folds displays striae which are remarkably similar to those of the Arctiidae and act as microtymbals (mi). Those microtymbals are usually not distinctly visible from the outside in normally set specimens, only sometimes in specimens with the wings folded upward (Fig. 2). The tymbal organs are always a little lighter in colour than the following segments, and when they are large they can even be slightly translucent. When they are small the easiest way to localize them is by checking the tergo-sternal membranes under which the oblique slits are situated. They can also be compared with the abdomina of corresponding females which do not possess this organ and where the sternites sometimes display vertical, but never oblique, clefts (telescoping of segments).

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Fig. 1. *Lymantria monacha* (L.) : latero-posterior view of abdomen with left tymbal organ, showing the deep subtriangular depression. *de* : depression, *me* : tergo-sternal membrane, *st3,4* : sternite of 3rd, 4th abdominal segments, *sw* : swelling, *tg3* : tergites of 3rd abdominal segment.

Fig. 2. *Olapa crocicollis* (HERRICH-SCHÄFFER) : latero-posterior view of abdomen with left tymbal organ, part of the microtymbals are visible. *cl* : lateral cleft, *me* : tergo-sternal membrane, *mi* : microtymbals, *st3,4* : sternite of 3rd, 4th abdominal segments, *sw* : swelling, *tg* : tergite of 3rd abdominal segment.

Fig. 3. *Olapa crocicollis* (HERRICH-SCHÄFFER) : inner view of abdomen with viscera removed showing right tymbal organ. *cl* : lateral cleft, *fo* : fold, *me* : tergo-sternal membrane, *mi* : microtymbals, *sp3* : spiracle of 3rd abdominal segment, *st3,4* : ventral cut through sternite of 3rd, and inner view of sternite of 4th abdominal segments *sw* : swelling, *st3,4* : tergites of 3rd, 4th abdominal segments.



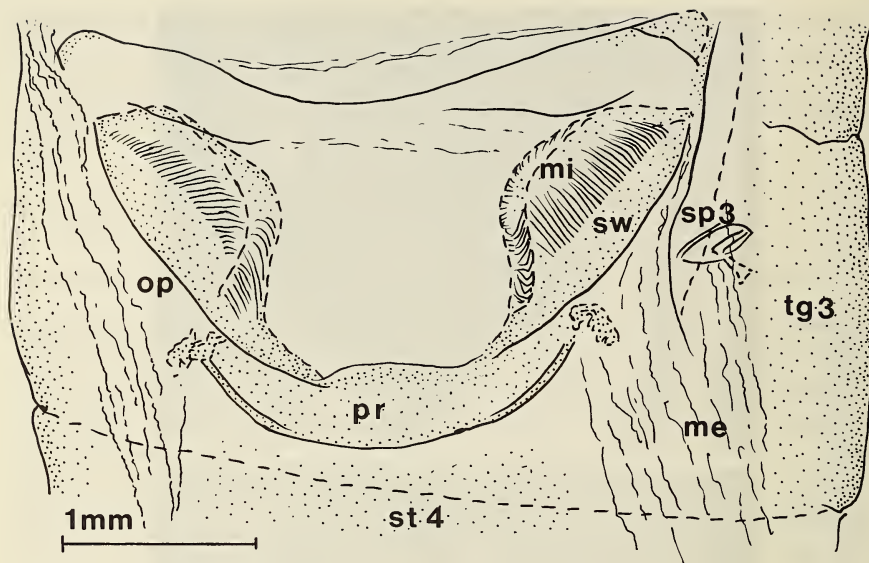


Fig. 4. *Stracena promelaena* (HOLLAND). Ventral view of abdomen in genitalia preparation. *mi*: microtymbals, *me* tergo-sternal membrane, *op*: opening, *pr*: protruding part of joined tymbal organs, *sp3*: spiracle of 3rd abdominal segment, *st4*: sternite of 4th abdominal segment, *sw*: swelling, *tg3*: tergite of 3rd abdominal segment.

PREPARATIONS (Fig. 4) : in slide preparations where the abdomen is mounted ventral side up, the swellings of the tymbal organs are pushed downward, their dorsal parts slip inside the abdomen and the 3rd segment seems thus as broad as the following ones. The dorsal portions of the swellings (*sw*), now inside the abdomen, stretch and completely flatten the inner folds. The surface possessing the microtymbals (*mi*) (lower plan in the slide) and the dorsal portion of the swelling (higher plan in the slide) have the appearance of blunt triangles or half circles with the rounded side directed inward. The opening (*op*) to the outside is oblique with regard to the posterior segment delimitation. When the tymbal organs are large, as in *Stracena*, this delimitation with the next segment can be more or less rounded and more strongly sclerotized, joining the paired tymbal organs in one protruding (*pr*) ventral structure. The organs are of variable size, from about the breadth of a segment to less than half of it. The microtymbals are a little closer to one another near the posterior part of the organ, a little further apart and less distinct at the anterior part. Sometimes only the posterior half of the organ is striated, in this case there are sometimes only a few microtymbals but there can be as many as about 50 (*Olapa*). When the tymbal organs are small and the proximal part of the abdomen is missing in the preparation, their

presence can easily be checked by counting the spiracles from the posterior end of the abdomen backward. In the Lymantriidae the spiracles of the abdominal segment preceding the genitalia are absent or very small, and when one counts them cephalad it can be said that the tymbal organs are always situated between the fifth pair of fully developed spiracles.

## Taxonomic distribution

Nearly all the species of Lymantriidae represented in the collections of the Musée royal de l'Afrique centrale (Tervuren), the Institut des Sciences naturelles de Belgique (Brussels) and the type species of the Madagascar genera in the Musée d'Histoire naturelle (Paris) have been checked for the presence of tymbal organs. These species cover most of the more than 200 recognised lymantriid genera (Table I). The presence or absence within the genera proved to be very irregular. The only genera in which the tymbal organs are always absent are those having brachypterous or wingless females (*Bracharoa* and *Orgyia*, to which our Vapourers belong). Neither, are they present in the Gipsy Moth (*Lymantria dispar* (LINNÉ)), the female of which is known to be a weak flier, but *Lymantria monacha* (LINNÉ) (our well known Black Arches, type species of genus and family) has very large tymbal organs. This presence and absence of the tymbal organs within the same genus also occurs in a few other groups of Lymantriidae. Although tymbal organs are present in many different genera belonging to very unrelated groups of the family, no taxon could be found homogenous with respect to this character. Assuming that the present genus concept of the family is largely correct, the only conclusion that can be drawn is that the tymbal organs were present very early in the phylogeny of the Lymantriidae and that they are readily lost in the course of evolution. It will only be possible to establish if these tymbal organs can be considered an apomorphy once a consistent classification becomes available for the whole family.

<i>Abakabaka</i> GRIVEAUD **	-	<i>Cimola</i> WALKER	-
<i>Anexotamos</i> HERING	-	<i>Collenettema</i> GRIVEAUD	-
<i>Ankova</i> GRIVEAUD **	-	<i>Conigephyra</i> COLLENETTE	+
<i>Arctornis</i> GERMAR	+	<i>Creagra</i> WALLENGREN	+
<i>Argyrotagma</i> AURIVILLIUS	-	<i>Cropera</i> WALKER	-
<i>Aroa</i> WALKER	-	<i>Crorema</i> WALKER	+
<i>Bracharoa</i> HAMPSON	-	<i>Croremopsis</i> HERING	+
<i>Cadorela</i> GRIVEAUD	-	<i>Dasychira</i> HÜBNER *	- & +
<i>Cadurca</i> SWINHOE	-	<i>Dasychoproctis</i> HERING	-
<i>Carriola</i> SWINHOE	-	<i>Decelleria</i> DALL'ASTA **	-
<i>Casama</i> WALKER	+	<i>Dediana</i> WALKER **	-
<i>Caviria</i> WALKER	+	<i>Dura</i> MOORE	+
<i>Chrysocyma</i> HAMPSON	-	<i>Eala</i> COLLENETTE	+
<i>Cifuna</i> WALKER	-	<i>Eloria</i> WALKER	+

<i>Eopirga</i> HERING	-	<i>Opoboa</i> TESSMANN	+
<i>Erika</i> GRIVEAUD **	-	<i>Orana</i> GRIVEAUD **	+
<i>Eudasychira</i> MÖSCHLER **	+	<i>Orgyia</i> OCHSENHEIMER	-
<i>Euproctidion</i> HOLLAND	+	<i>Otroeda</i> WALKER	+
<i>Euproctis</i> HÜBNER	- & +	<i>Palasea</i> WALLENGREN	+
<i>Euproctoides</i> BETHUNE-BAKER	+	<i>Pantana</i> WALKER	-
<i>Fanala</i> GRIVEAUD **	+	<i>Paqueta</i> DALL'ASTA **	-
<i>Gallienica</i> GRIVEAUD **	-	<i>Parabatella</i> DALL'ASTA **	+
<i>Grammoa</i> AURIVILLIUS	+	<i>Paramarbla</i> COLLENETTE	+
<i>Griveaudyria</i> VIETTE **	-	<i>Parapirga</i> BETHUNE-BAKER	+
<i>Hemerophanes</i> COLLENETTE	-	<i>Paraproctis</i> BETHUNE-BAKER	-
<i>Heteronygmia</i> HOLLAND	+	<i>Pelorosos</i> COLLENETTE	+
<i>Homochira</i> HAMPSON	-	<i>Perina</i> WALKER	-
<i>Homoeomeria</i> WALLENGREN	+	<i>Pirga</i> AURIVILLIUS	+
<i>Hyaloperina</i> AURIVILLIUS	+	<i>Pirgula</i> TESSMANN	+
<i>Hypogyma</i> HÜBNER	-	<i>Polymona</i> WALKER	+
<i>Imaus</i> MOORE	+	<i>Porthesaroa</i> HERING	+
<i>Jabaina</i> GRIVEAUD **	+	<i>Psalis</i> HÜBNER	-
<i>Jacksoniana</i> NYE	-	<i>Pseudobazisa</i> BRYK	- & +
<i>Kanchia</i> MOORE	+	<i>Pseudonotodonta</i> MÖSCHLER **	-
<i>Kintana</i> GRIVEAUD **	+	<i>Pteredoa</i> HAMPSON	-
<i>Labordea</i> GRIVEAUD **	-	<i>Pyrrhopteryx</i> HERING	+
<i>Lacipa</i> WALKER	-	<i>Rahona</i> GRIVEAUD **	+
<i>Laelia</i> STEPHENS	- & +	<i>Redoa</i> WALKER	+
<i>Laeliolina</i> HERING	-	<i>Rhodesana</i> BETHUNE-BAKER **	-
<i>Laelioprocitis</i> HERING	-	<i>Rivotra</i> GRIVEAUD **	+
<i>Lanitra</i> GRIVEAUD **	+	<i>Rhypteryx</i> AURIVILLIUS	+
<i>Leptepilepta</i> COLLENETTE	+	<i>Salvatgea</i> GRIVEAUD	-
<i>Leucoma</i> HÜBNER	+	<i>Scaphocera</i> SAALMÜLLER	+
<i>Leucoperina</i> AURIVILLIUS	+	<i>Sirana</i> GRIVEAUD **	-
<i>Lomadonta</i> HOLLAND	-	<i>Sphragista</i> COLLENETTE	+
<i>Lymantica</i> COLLENETTE	+	<i>Stenaroa</i> HAMPSON	+
<i>Lymantria</i> HÜBNER	- & +	<i>Stilpnaroma</i> HERING	-
<i>Lymantriades</i> BETHUNE-BAKER	-	<i>Stracena</i> SWINHOE	+
<i>Madema</i> GRIVEAUD	+	<i>Stracilla</i> AURIVILLIUS	-
<i>Marbla</i> SWINHOE	-	<i>Sychnacedes</i> COLLENETTE	+
<i>Marblepsis</i> HERING	+	<i>Terphothrix</i> HOLLAND	-
<i>Mpanjaka</i> GRIVEAUD **	+	<i>Thambeta</i> COLLENETTE	+
<i>Mylantria</i> AURIVILLIUS	-	<i>Topomesoides</i> STRAND	+
<i>Naroma</i> WALKER	+	<i>Turlina</i> GRIVEAUD **	-
<i>Neomardara</i> HERING	-	<i>Usimbara</i> COLLENETTE	+
<i>Noleca</i> WALKER **	-	<i>Varatra</i> GRIVEAUD **	+
<i>Noliproctis</i> HERING	+	<i>Viettema</i> GRIVEAUD	+
<i>Notohyba</i> HOLLAND **	+	<i>Viridichira</i> DALL'ASTA **	-
<i>Ocneria</i> HÜBNER	- & +	<i>Viridichirana</i> DALL'ASTA **	-
<i>Oecura</i> HOLLAND **	-	<i>Vohitra</i> GRIVEAUD **	+
<i>Ogoa</i> WALKER	+	<i>Volana</i> GRIVEAUD **	+
<i>Olapa</i> WALKER	+	<i>Zavana</i> GRIVEAUD **	+

Table 1. The lymantriid genera checked for the presence (+) or absence (-) of tymbal organs.

\* *Dasychira* sensu COLLENETTE (1955).

\*\* Congeneric with *Dasychira* sensu COLLENETTE (1955), but now considered distinct.

## Function

In Arctiid moths the tymbal organs are present in both sexes. BLEST *et al.* (1963) could not decide on the function of these organs : aposematic or pseudaposematic signal (warning signal), echolocation, courtship, or possibly a peculiar defence system ("peaky" signals could embroil the echos of bats). In the wax moth *Achroia grisella* (FABRICIUS) on the other hand the tymbal organs are present only in males and their function in mating behaviour has been suggested (SPANGLER *et al.*, 1984). Over long distances the females are probably attracted by pheromone emission, but this stimulus alone (produced in experimental conditions by males without tegulae) proved to be less effective for their location on short distances by the females than when combined with sound production. Tymbal organs of Lymantriidae are also only present in males. They are absent in males of species with wingless females and also in males of some where females are known as poor fliers. This suggests that they could have a function in mating behaviour like that of the wax moth where mating is facilitated by male signaling and female searching, the reverse of the so-called moth system. If this could be verified by experiment it would show that this reverse is much less uncommon than outlined by GREENFIELD (1981).

## Acknowledgements

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