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Chemical *vs* acoustic cues in the defence of arctiid moths (Lepidoptera) against small mammals

Chemische versus akustische Signale beim Schutz von Bärenspinnern (Lepidoptera: Arctiidae) gegenüber Kleinsäugern

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The unpalatability of many moths, which is due to sequestration of secondary plant chemicals or self-produced toxins, is believed to be linked with aposematic colouring and/or behaviour, often in addition to disturbance stridulation. The question is whether acoustic and chemical signals operate against different predators or rather complement and/or support each other.

Experiments were conducted to test the operation of chemical defence with pyrrolizidine alkaloids (PAs) and of acoustic signals in ***Rhodogastria phaedra*** (Lep.: Arctiidae) on long-eared bats (***Plecotus auritus***) and yellow-necked field mice (***Apodemus flavicollis***) as predators. Moths were reared on a semi-artificial diet free of PAs [-PA]; the adults are pharmacophagous with respect to PAs and ingest these defensive plant compounds in purified form liberately and independently of food uptake [+PA]. Sound production can be eliminated [-S] by cutting the tymbal organ, which does not affect the moths' behaviour.

Initially, bats/mice had approached ***Rhodogastria*** erratically, however, after a few days they got accustomed to the novel prey and attacked the moths predictably within a minute or less. At this stage we started the experiments: Daily, three to six moths were presented individually to each of two bats and five mice. Moths which were not grasped within 10 minutes were scored as "ignored" and removed from the experiment before another specimen was offered. Since always other food (noctuids/seeds) has been provided in addition, bats/mice were never forced to feed on ***Rhodogastria***.

I. During the initial experimental phase of five to six days bats/mice caught and consumed almost all [-PA,+S]-moths offered and ignored just 10.9% (n=55) / 0.7% (n=139), which shows that sound has little if any effect.

II. For the following three days [+PA,+S]-moths were offered but less accepted from day to day resulting on average in 68.2% (n=22) ignored by the bats and 50% (n=50) by the mice, and the majority of the insects caught were not consumed entirely.

III. Eventually, [-PA,+S]-moths were presented again for the next five days, revealing a slight increase of ignored moths to 75% (n=49) for the bats, and a decrease to 10% (n=110) for the mice.

The experiments with the bats were continued for three days with [-PA,-S]-moths and revealed a drop of ignored moths to 15.6% (n=32); however, as many as 76.9% (n=13) of [+PA,-S]-moths were ignored during the following two days. For the final two days, when [-PA,-S]-moths were offered again, as little as 25% (n=20) were ignored.

These results clearly indicate that the ultrasonic signals produced by disturbed ***Rhodogastria*** act repelling on long-eared bats but only in the context of experience with repelling chemicals; ***i.e.***, the acoustic signals are aposematic features and thus antipredator devices which complement chemical defence. Likely, in bats there is a preadaptation for learning to associate acoustic signals with unpalatability of prey. In contrast, yellow-necked field mice choosing prey are not considerably affected by sounds, rather gustatory and/or olfactory cues seem to be of greater relevance.

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