

# A pilot study in Uganda: *Gabonia* (Col.: Chrysomelidae: Alticinae) and pyrrolizidine alkaloids

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## Summary

In various habitats in Kenya and Uganda, more than 18 species (13 or more of which unknown to science) of the alticine genus *Gabonia* (Coleo-ptera: Chrysomelidae) have been found at dry plants containing pyrrolizidine alkaloids or were baited with pure PAs. Such "pharmacophagous" behaviour was only exhibited by males, and parallels to various lepidopteran genera and to *Zonocerus* (Orthoptera) are obvious: these groups independent of nutrient requirements actively search for sources of these secondary plant compounds and take them up to increase their fitness; the Lepidoptera store PAs to gain protection from antagonists, in addition in some they serve as precursors for the biosynthesis of male courtship pheromones.

The sex-biased behaviour towards PAs in *Gabonia* as well as the presence of complex glands on antennae, tibiae, caput and elytra suggest that in these beetles PA-uptake and mate-choice are related. So far, pheromones are unknown in Chrysomelidae. Multifold experimental approaches on proximate as well as ultimate questions are obvious, however, they cannot be approached practically because on the one hand only single females are known for a few *Gabonia* species and on the other no information on adult and larval host-plants is available.

The forests around the field station of Makerere University at Kibale National Park / Uganda do house several species of *Gabonia* and the station provides excellent scientific infrastructure; therefore, we want to do a pilot study at MUBFS and investigate the basic biology and ecology of *Gabonia* to serve as a basis for experimental studies.

## State of the art

About 50 species of *Gabonia* have been described for East Africa. Only two publications are available which report some biological observations on *Gabonia* (made at PA-baits) (Boppré & Scherer 1981; Scherer & Boppré 1997): We know, for example, that some species go for PA-baits exclusively during day, others only at night.

Histological studies on the male glands are as yet unpublished (Fischer & Boppré, in prep.; cf. Fig. 3).

Lepidoptera with similar responses

to PAs (Danainae, Arctiidae, and others) are quite well investigated from several points of view (chemically, morphologically, ethologically, physiologically); this knowledge is published in several review papers: e.g., Boppré 1986, 1990, 1995, 1997.

In a wider context, there are detailed studies on European leaf beetles, some of which utilize PA-plants as primary hostplants and secrete PAs (taken up with food) through defensive glands (z.B. Pasteels et al. 1996).

A parallel to PA-pharmacophagy is exhibited by several other insects which take up and utilize cantharidin. Respective publications (e.g., Holz & Dettner 1994; Eisner et al. 1996a,b) provide additional hypotheses for studies on *Gabonia*.

Techniques for qualitative and quantitative chemical analyses of *Gabonia* with respect to PAs and PA derivatives are elaborated and available at the FZI (GLC, GLC-MS, EAD). There is cooperation on chemical aspects with Prof. Francke (Hamburg), Dr. Wiedenfeld (Bonn) und Prof. Hartmann (Braunschweig).

## References

- Boppré M (1984) Redefining „pharmacophagy“. *J Chem Ecol* 10: 1151-1154
- Boppré M (1986) Insects pharmacophagously utilizing defensive plant chemicals (pyrrolizidine alkaloids). *Naturwissenschaften* 73: 17-26
- Boppré M (1990) Lepidoptera and pyrrolizidine alkaloids: exemplification of complexity in chemical ecology. *J Chem Ecol* 16: 165-185
- Boppré M (1995) Pharmacophagie: Drogen, Sex und Schmetterlinge. *Biologie in unserer Zeit* 25: 8-17
- Boppré M (1997) Pharmacophagy in adult Lepidoptera: the diversity of a syndrome. Pp 285-289 in Ulrich H (ed.) *Tropical Biodiversity and Systematics. Proc Intern Symp Biodiversity and Systematics in Tropical Ecosystems*. D-Bonn: ZFMK
- Boppré M, Scherer G (1981) A new species of flea beetle (Alticinae) showing male-biased feeding at withered Heliotropium plants. *System Entomol* 6: 347-354
- Eisner T, Smedley SR, Young DK, Eisner M, Roach B, Meinwald J (1996a) Chemical basis of courtship in a beetle (*Neopyrochroa flabellata*): cantharidin as precopulatory "enticing" agent. *Proc Natl Acad Sci USA* 93: 6494-6498
- Eisner T, Smedley SR, Young DK, Eisner M, Roach B, Meinwald J (1996b) Chemical basis of courtship in a beetle (*Neopyrochroa flabellata*): cantharidin as precopulatory "nuptial" gift. *Proc Natl Acad Sci USA* 93: 6499-6503
- Fischer OW, Boppré M (1997) Chemoecological studies reveal causes for increased population densities of *Zonocerus* (Orth.: Pyrgomorphidae) and offer new means for management. Pp 265-279 in Krall S, Peveling R, Ba Diallo D (eds) *New Strategies in Locust Control*. CH-Basel: Birkhäuser Verlag
- Fischer OW, Boppré M (Manuskript) Exocrine antennal glands in males of *Gabonia gabriela* (Col.: Chrysomelidae: Alticinae).
- Holz C, Dettner K (1994) Cantharidin-Transfer bei *Schizotus pectinicornis* (Coleoptera, Pyrochroidae). *Verh Dtsch Zool Ges* 1994: 245
- Pasteels JM, Rowell-Rahier M, Ehmk A, Hartmann T (1996) Host-derived pyrrolizidine alkaloids in *Oreina* leaf beetles: physiological, ecological and evolutionary aspects. Pp 213-225 in Jolivet PHA, Cox ML (eds) *Chrysomelidae Biology*, Vol. 2. NL-Amsterdam: SPB Acad Publ
- Scherer G, Boppré M (1997) Attraction of *Gabonia* and *Nzerekorena* to pyrrolizidine alkaloids – with descriptions of 13 new species and notes on male structural peculiarities (Insecta, Coleoptera, Chrysomelidae, Alticinae). *Spixiana* 20: 7-38

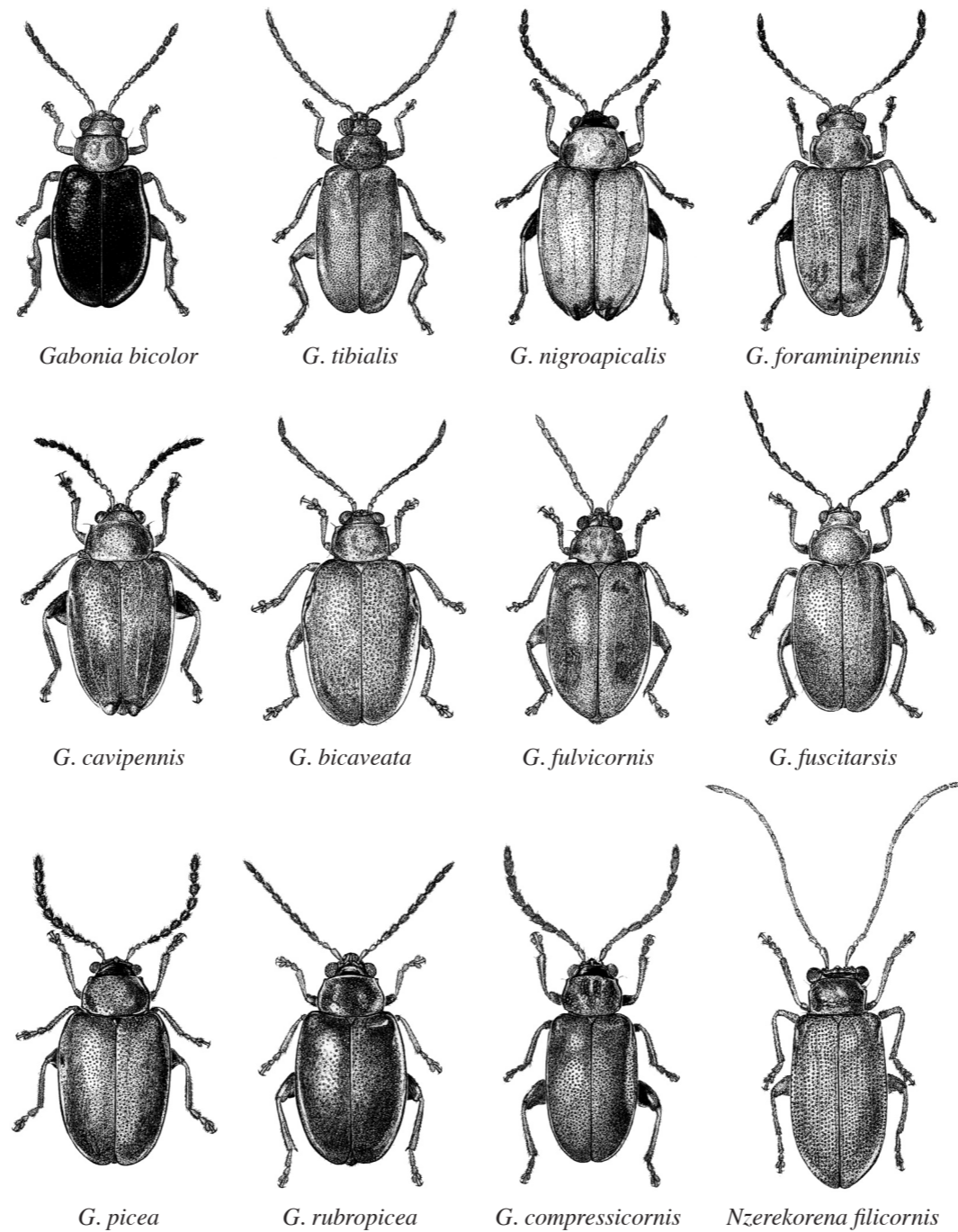


Fig. 2 Males of some of the newly described species collected at PA-baits in Kenya. 1 mm = — (From: Scherer & Boppré 1997)

## Goals and working programme

The final goal is to describe and characterize experimentally the relation of adult beetles of the African leaf beetle genus *Gabonia* to pyrrolizidine alkaloids (qualitative and quantitative aspects of attraction to and uptake of PAs) and functions of the uptake of PAs (in particular, storage for defence, role in mate-choice). Furthermore, in the course of a taxonomic revision of *Gabonia* and closely related genera questions on

the phylogeny of pharmacophagy within the Coleoptera will be considered, in particular in comparison with pharmacophagous Lepidoptera.

The goal of the pilot study is to provide the basis for experimental studies, i.e. systematic search for and finding of - hostplants (nutritional hosts) of adult *Gabonia*, - females of at least some of the *Gabonia* spp., - hostplants of *Gabonia* larvae.

The field studies will also reveal data on dial activities and on the specificity of attraction of *Gabonia* to different sources of PAs; as yet unknown natural sources of PAs will be looked for. Such information will also be relevant for experimental studies.

## Field studies:

1. In the forest adjacent Makerere University Biological Field Station (MUBFS) near Kanyawara in Kibale Forest, baits (pure PAs, i.e. standardized baits) are being distributed and regularly checked for attracted beetles (during day and night).

With the aid of data from baiting tests, habitats are being localized, perhaps different ones for different species.

In the vicinity of such 'hot spots' pin-point searches for feeding damage (adult Alticinae usually cause holes or windows in leaves) and beetles are being conducted, not only by searching but also by beating plants at different heights and at different times. Ground litter is also being sieved and roots and stems will be examined for larvae.

2. Baited beetles are being confined in containers where plants from the vicinity of

the baiting spots will be offered for feeding. Accepted plants are being tested repeatedly with different species.

3. After having found hostplant(s), seeds and cuttings for cultivation in a greenhouse are collected.
4. Yet unknown natural sources for PAs in the forest are being searched for.
5. Baited/ collected beetles are being prepared for taxonomic, chemical and histological studies.
6. Hostplants and PA-plants are prepared for a herbarium. Determinations are done at MUBFS or with the aid of herbaria in Kampala/Uganda, Nairobi/Kenya and/or Kew/England.

## Studies in the laboratory:

1. Cultivation of hostplants in a greenhouse.
2. Evaluation of baited *Gabonia* (spectrum of species, dial activity, specificity towards pure PAs).
3. Taxonomic studies of chrysomelids from Boppré's collection originating from baiting tests in several African countries.
4. Determination of hostplants and PA-containing plants.
5. Chemical analyses of presumed PA-plants found.

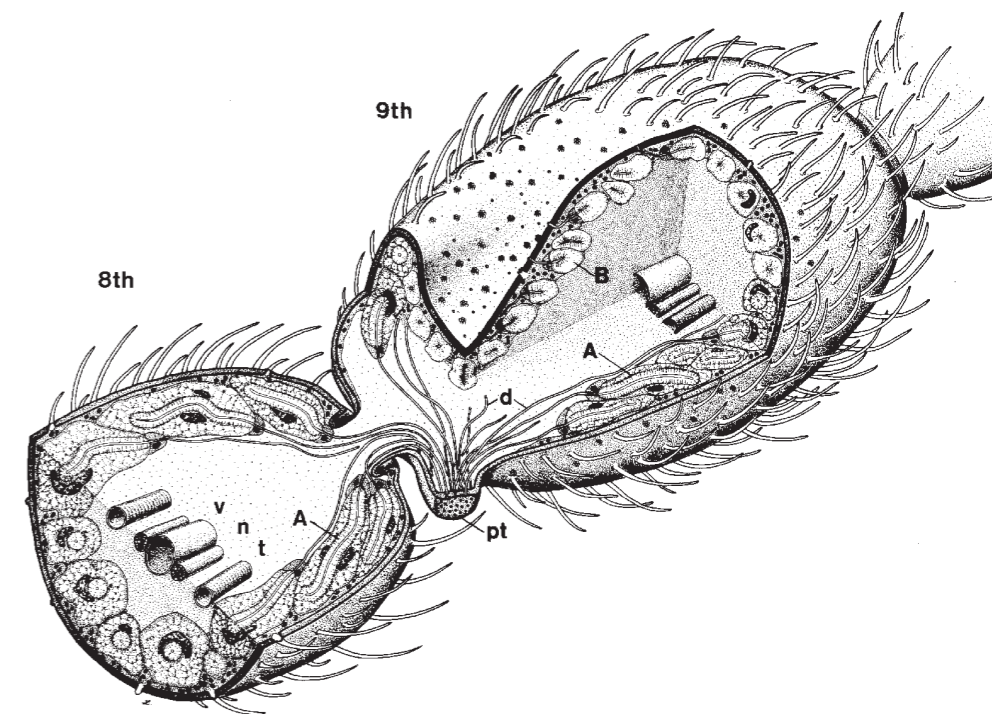


Fig. 3 Segments 8 and 9 of the antennae of male *Gabonia gabriela* are enlarged and contain 2 types of large glandular cells (A, B), which send ducts (d) to a 'poreplate' (pt) at the 9th segment. (From manuscript in preparation by O.W. Fischer & M. Boppré)