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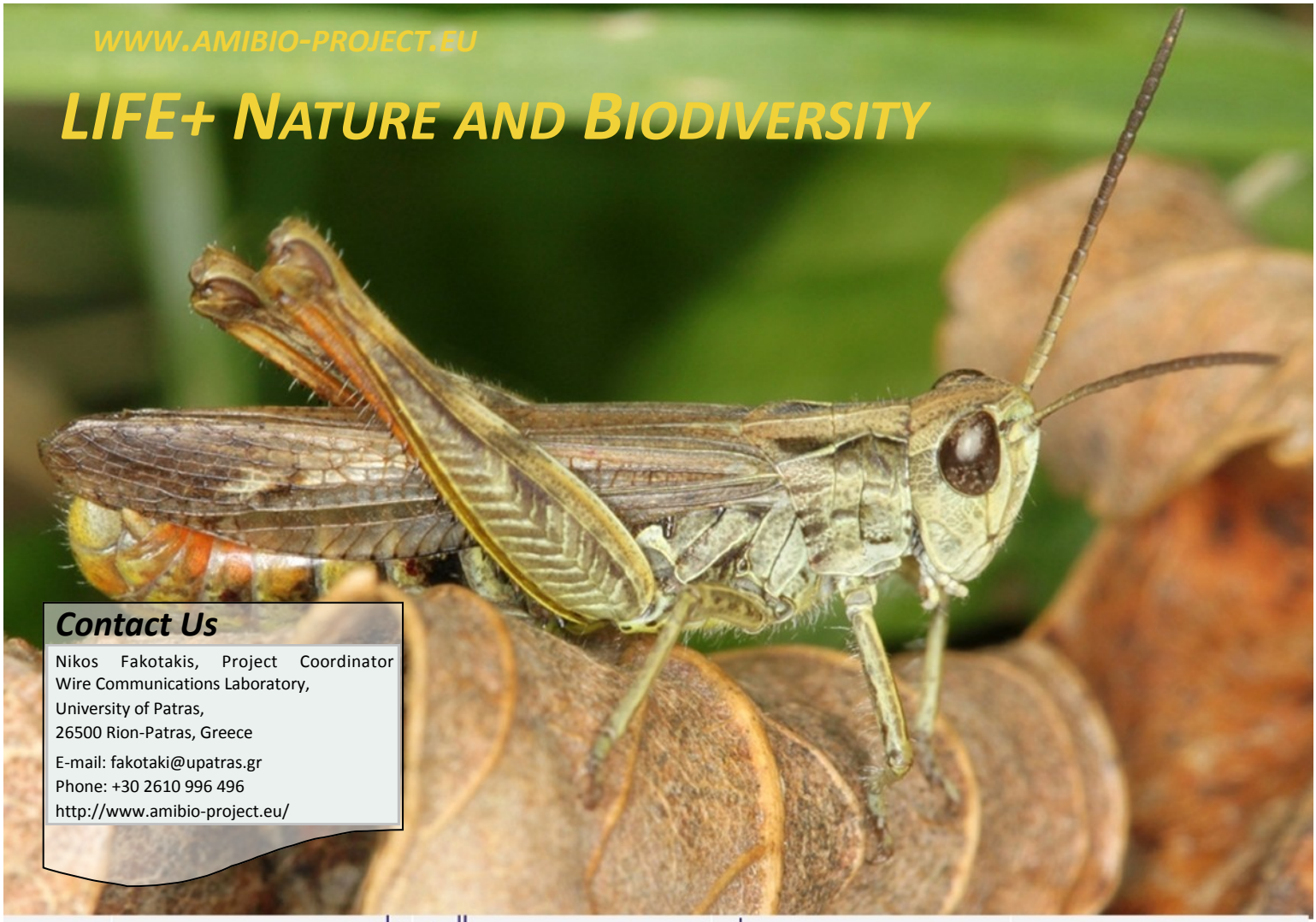

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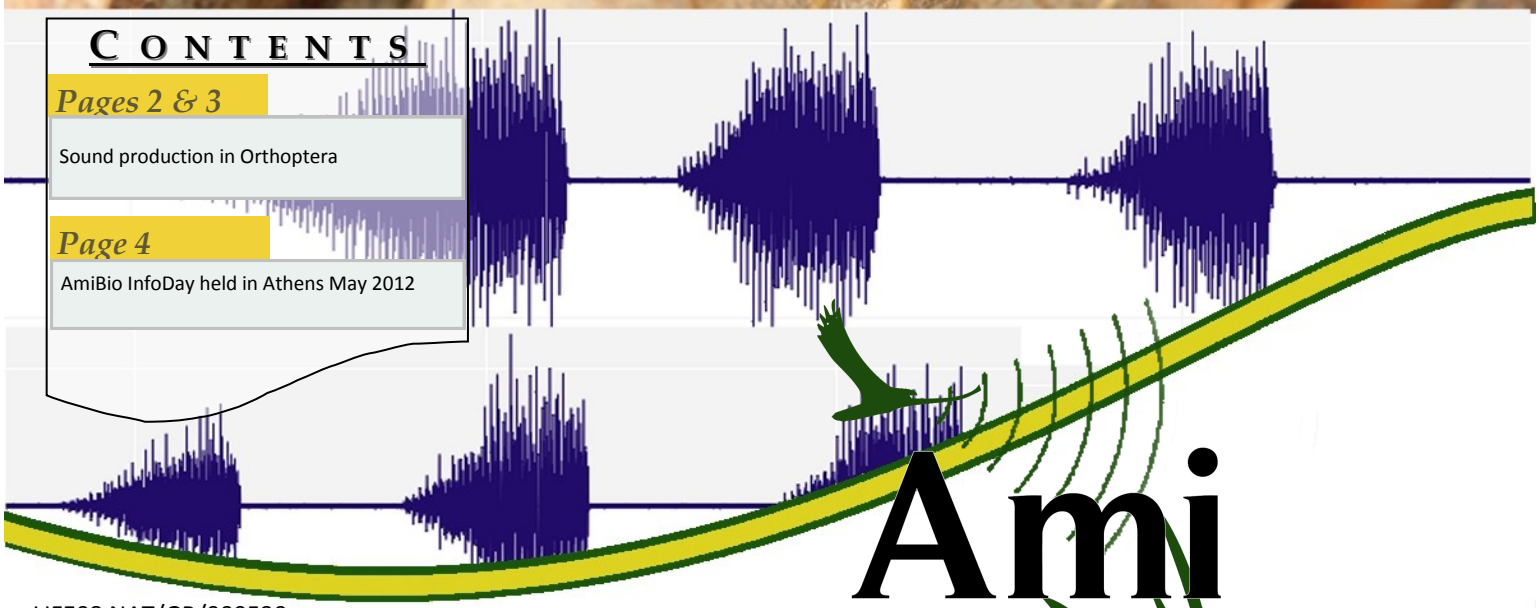

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Review Article

ORTHOPTERA AND THEIR SOUND PRODUCTION

by S. Ingrisch, I. Potamitis

Sounds can be produced by insects in different ways. Most commonly used are:
Stridulation: friction of two body parts; usually heard as chirping (examples: crickets, katydids, grasshoppers, bugs, beetles, moths, ants)
Drumming: tapping a body part, e.g. feet (oak bush-cricket), tip of abdomen (cockroaches), or head (death-watch beetle) against the substrate
Vibration: oscillation of body parts such as wings in the air; usually heard as humming or rumbling (mosquitoes, flies, wasps, bees)
Tymbal Mechanism: quick contraction and release of tymbal muscles (vibrating drum-like membranes); usually heard as a series of clicking sounds (cicadas, leafhoppers, treehoppers, spittlebugs)
Air Expulsion: ejection of air or fluid through a body constriction; usually heard as a whistle or hiss (hissing cockroach).

Sound production in Orthoptera is usually done by stridulation although other methods as drumming with legs on a surface or flapping with wings and others are also known. Stridulation is done by rubbing two parts of the body against each other. Two different solutions in doing so are realised in Orthoptera. In Ensifera, i.e. crickets and bush-crickets or katydids, this is done by rubbing specialised parts of both fore wings against each other, while in Caelifera, i.e. grasshoppers and locusts, the femora of the hind legs are rubbed against the fore wings.

In Ensifera (long-horn orthopterans), part of the dorsal area of both fore wings is specialised to produce sounds. Thereby Tettigoniidae (bush-crickets or katydids) stridulate left wing over right wing, while Gryllidae (true crickets) do the opposite, right wing over left wing. The stridulatory area of Tettigoniidae is a rather small stiffened area at the base of the fore wings. The stridulatory vein of the upper (left) fore wing is usually thickened and carries on the underside of the wing the stridulatory file (Photo 2, left A,B). The file is covered by a series of teeth, the number of which varies between species. The lower (right) forewing holds the scraper, a stiffened part of the margin, that scrapes over the stridulatory vein during sound production. It also contains the mirror, a transparent membrane that helps amplifying the sound produced. Only males of Ensifera have this type of elytro-elytral stridulatory apparatus. Females are normally mute, but in some subgroups of Tettigoniidae as Phaneropterinae (leaf katydids) also females developed an elytral stridulation that is distinctly more quiet than in males.

Photo 1. Males of the long-legged leaf katydids of the genus *Acrometopa* produce characteristic loud songs that have been recorded and were recognized by our acoustic monitoring system [male of *Acrometopa syriaca* Brunner v. Wattenwyl, 1878 photographed at Nea Chili near Alexandropoulis in 1971].

Within the short-horned grasshoppers (Caelifera), the femuro-elytral stridulatory apparatus of the Acrididae has two subtypes. (1) In gomphocerine grasshoppers, which form the majority of meadow grasshoppers in Europe and temperate Asia, there is a stridulatory ridge on the inner side of the hind femur that is provided with a row of numerous small pegs (Photo 2, right, A,B). These pegs are rubbed against a projecting vein, the radius, of the fore wings during up and down movements of the hind legs. (2) In oedipodine grasshoppers it is opposite. A specialised vein, the vena intercalata in the medial field of the fore wings, carries minute teeth while the ridge on the inner side of the hind femur is without teeth. Stridulation of oedipodine grasshoppers is less conspicuous than in gomphocerine grasshoppers. In Gomphocerinae also females may stridulate during pair formation but not as loud as males.
The most common function of stridulation in Orthoptera is mate finding with males singing to attract females. In some species of Phaneropterinae complex response systems of male and female evolved to serve this purpose. Other functions of stridulation are aggression, rivalry, defense or in gomphocerine grasshoppers it was also observed to contribute to cohesion of a population. Representatives from all Orthoptera families and subfamilies can be found at Hymmetus.

The location of the tympanal organ, the"ear" of Orthoptera, also differs between Ensifera and Caelifera. In Ensifera the tympana are located in the tibia of the forelegs. Normally there is a tympanum on both sides of the tibia, in some cricket species only on one side. The tympana may be openly visible in some species or covered by conchate folds of the integument in others, leaving only a slit in front. Below the tympana there are the receptors, the crista acustica, and a pair of large trachea that run from the tibia to the acoustic spiracle in the thorax.
In Caelifera the tympanal organ lies in the first segment of the abdomen. It is normally hidden under the wings or the hind legs. Only in the families Pamphagidae and Pyrgomorphidae it is open; in the family Acrididae, the large tympanum lies oblique to the body surface, sunk in and is bordered by a rim that forms an open "cave" above the tympanum. The receptor lies below the tympanum.

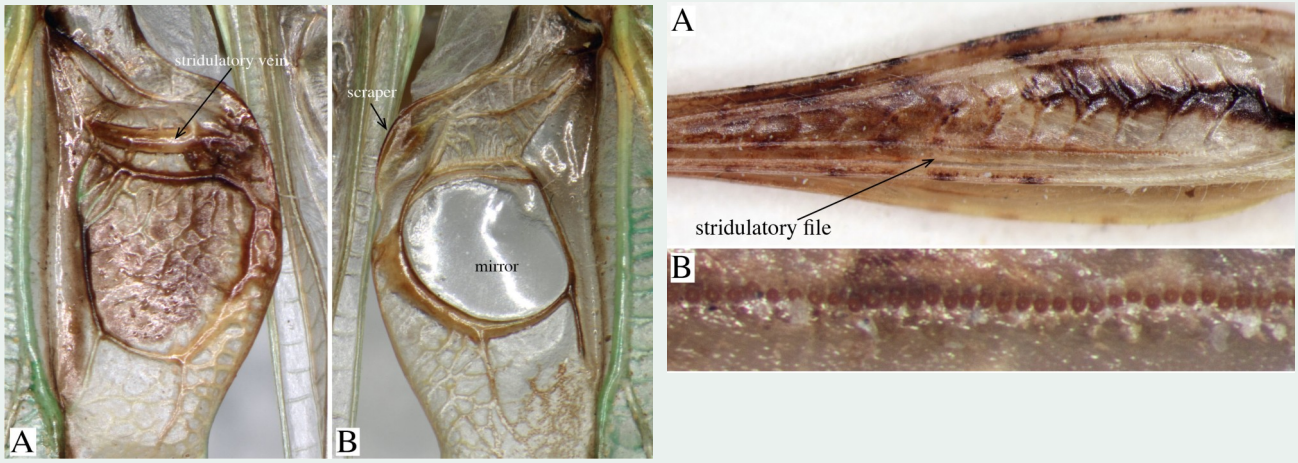

Photo 2: Left: Stridulatory area of the Great Green Bush-cricket *Tettigonia viridissima* (L., 1758) on (A) upper (left) fore wing and (B) lower (right) fore wing. Right: A. Stridulatory file on the inner surface of the left hind femur of the Bow-winged Grasshopper *Chorthippus biguttulus* (L., 1758); B. a series of pegs in greater enlargement. .

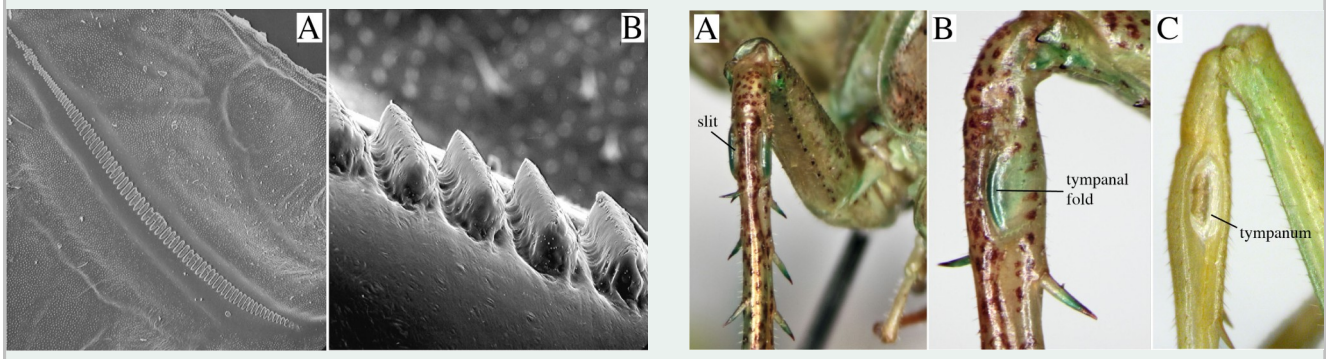

Photo 3: Left: Stridulatory file on underside of left tegmen of *Tettigonia cantans* (Fuessly, 1775); (B) a few teeth in great enlargement. SEM micrographs by K.G. Heller.
Right: Tibial tympana of *Tettigonia viridissima* a species with covered tympana in anterior view; (B) same in internal view; (C) internal tibial tympanum of the Oak Bush-cricket *Meconema thalassinum* (De Geer, 1773) a species with open tympana.

Photo 4: *Chorthippus biguttulus* .

Photo 5: *Tettigonia viridissima*.

INFODAY IN GREECE

by N. Fakotakis

On the 18th of May, 2012, the AmiBio project organized an InfoDay in Athens, entitled "Long-term monitoring of biodiversity in the area of Hymettus Mountain". The aim of this InfoDay was to consolidate the public awareness in the project development.

Potential users of the AmiBio technology, researchers, developers, members of the administrative authorities and the wider public were invited to attend the information day and had the opportunity to receive up-to-date information on AmiBio innovative concept and technology. The information day made possible the two-way face-to-face communication between the consortium and the potential beneficiaries of the project outcomes.

Photo 1: Dr. N. Kanellopoulos, President of Demokritos Research Institute, opening the AmiBio InfoDay

Prof. Nikos Fakotakis, Prof. Klaus Riede, Dr. Olaf Jahn and Mr. Basilis Nomikos, presented details on project concept, implementation and results, always in connection to the Hymettus Mountain particularities. Except of the AmiBio dedicated sessions, two other projects were invited and presented during the event: (i) Dr. Kostas Eleftheriadis, researcher at Demokritos Research Institute, presented the ACEPT-AIR Life+ project, New Technologies assisting Environmental Policy making, for improving air quality in urban areas, and (ii) Dr. Xenophon Tsilibaris, Project manager at GRNET, presented the Natural Europe FP7 project, Innovative educational and collection management tools for Natural History Museums. In addition, Dr. Katerina Raftopoulou, Life+ Monitoring Expert at ASTRALE, provided the insights on the LIFE: The EU's Financial Instrument for the Environment and Nature Conservation. The interest of the attendants in AmiBio InfoDay was mainly environment protection (58%), research (18%) or policy making (12%).

Photo 2: Prof. Nikos Fakotakis, Dr. Olaf Jahn and Prof. Klaus Riede

Photo 3: Dr. Katerina Raftopoulou, Prof. Nikos Fakotakis and Mr. Basilis Nomikos

Cover photo: *Male of the* Bow-winged Grasshopper Chorthippus biguttulus *and corresponding oscillogram of its calling song. Editors of July 2012 newsletter Dr. Ilyas Potamitis and Petros Petrakis*