In focus

AmiBio inspires research on the Marginated Tortoise

Fig. 5. Main plateau of the Ergani Valley, a former marble quarry.

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In other words, for these sites it is reasonable to assume that the majority of tortoises detected by the sound-recording stations pertain to the former species, not to *T. hermanni*.

The Ergani Valley obviously is an ideal reproductive site for the Marginated Tortoise, which satisfies the ecological requirements of the species, such as high population density of reproductive adults, abundant food resources, nest sites, and shelter. Besides being an important breeding site for this tortoise, the valley provides habitats for several other animal species of conservation concern, particularly birds (e.g., Lesser Kestrel *Falco naumanni*, Peregrine Falcon *Falco peregrinus*, Short-toed Snake-Eagle *Circaetus gallicus*, Long-legged Buzzard *Buteo rufinus*, Red-backed Shrike *Lanius collurio*, and Cretzschmar's Bunting *Emberiza caesia*) and the European Green Toad *Pseudepidalea viridis*. Ergani currently is affected by strong anthropogenic pressures due to uncontrolled dumping of construction waste and illegal motocross activities, causing an immense negative environmental impact. This situation suggests the urgent need of a conservation action plan for the area to maintain favorable ecological conditions for species protected under EU legislation.

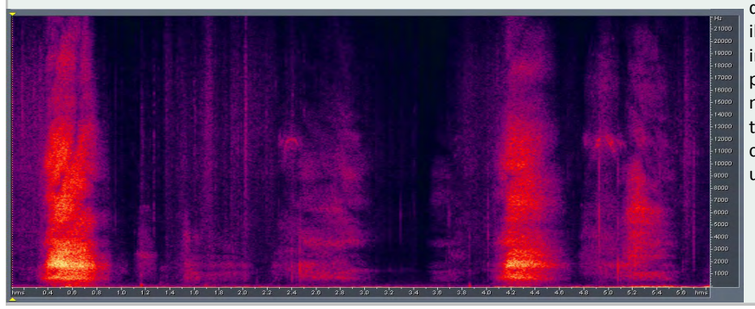

Fig. 6. *Recording of the hissing noises of a Marginated Tortoise*

Project progress

Steady Progress with the AmiBio Technology Development

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recording station, provides the processing capability and the memory storage needed for implementing the data collection, compression and transmission processes. Two USB hubs are used for increasing the number of connected USB devices. The USB hub 1 connects the single-board computer with the hardware associated with the audio acquisition, which includes the microphones, the microphone amplifiers, and the analog-to-digital converters. A typical configuration of the data acquisition, for the needs of AmiBio is 4-channel audio recording with sampling rate 44.1 kHz, 16-bit per sample, or alternatively one of the channels could be ultrasonic with sampling rate of 250 kHz and 16-bits per sample.

The USB hub 2 accommodates the 3G modem, the portable weather station and the USB luminosity sensor. The 3G link provides the communication capability of the sound-recording station and facilitates the real-time transmission of the multichannel audio and environmental data to the central base station.

In addition, a WiFi link (part of the external antenna attached to the single-board computer is shown in Fig.2) provides connectivity to a local wireless sensor network (WSN) that is deployed in the proximity of the sound recording station. This is a special-purpose design that will be deployed at one pre-selected micro-site at Hymettus Mountain. This design aims to study and evaluate few experimental setups for population density estimation for bird and insect species. The local WSN will consist of sound-sensitive sensor nodes (MICA2) and has the purpose to implement efficient sound source localization in a larger area (e.g. 100x100m or 200x200m). Detecting the location of sound emitting sources within a certain area is necessary for the purpose of population density estimation. Finally, the power supply components comprise a solar panel, charger and a rechargeable battery, which aim to guarantee the long-term autonomy of the sound-recording station (Fig.2). The successful completion of Action A.5 and A.6 provided the basis for remote, automated, simultaneous acquisition of data from multiple habitats. It also places the ground for automated data collection in support of the implementation of software for automated monitoring (Action A.7) of the acoustic activity of fauna at Hymettus Mountain. On the long term the outcome from the AmiBio Actions A.5, A.6 and A.7 provide the means for automated statistical analysis of the biodiversity trends in the monitored areas.

Cover photo: *Couple of Marginated Tortoise, photographed by ZFMK biology students, M. Konz and L. Lemm, in the Hymettus area.*

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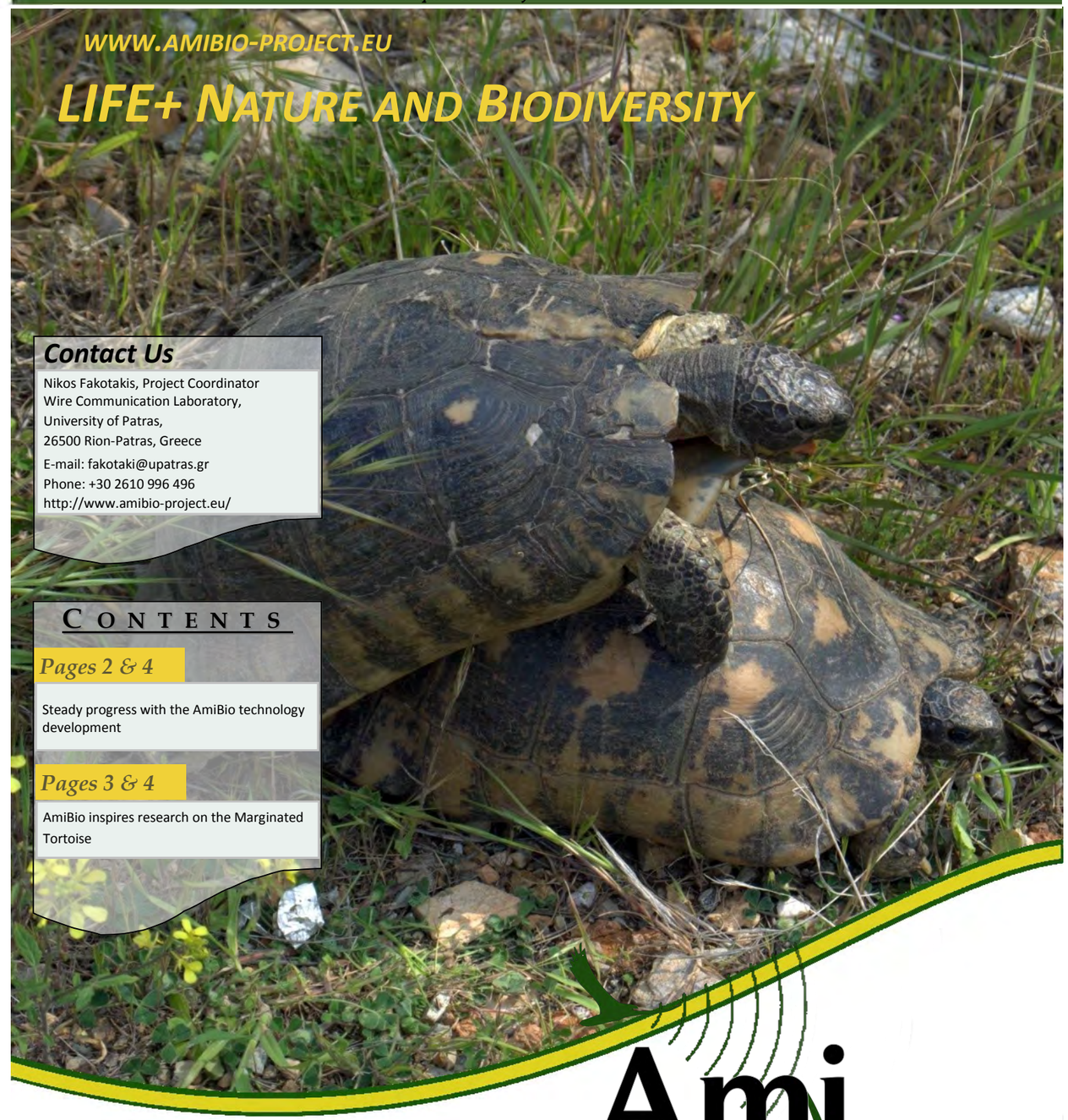

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by Todor Ganchev and Konstantinos Birkos

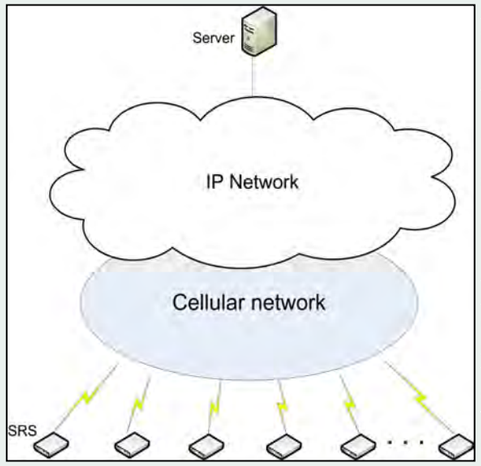

Fig. 1. *Overall architecture of the data communication*

At the beginning of 2011, the AmiBio project entered the second year of its implementation. During this second year, the main effort could be characterized as technology development activities. In brief, three AmiBio technology development actions started in January 2011:

- Action A.5 "Development of data acquisition module for the sensor nodes",
- Action A.6 "Development of wireless sensor network – architecture and communication protocols",
- Action A.7 "Development of software framework for data collection, pre-processing and delivery", and, in addition,
- Action A.8 "Development of data repository and tools" started in April 2011.

Actions A.7 and A.8, which aim to develop the software framework for data processing and the database management tools, are presently on-going and will conclude in November 2011. Thus, in the following we focus on the outcome of Actions A.5 and A.6, which had a duration of six months and are now completed.

The successful completion of the AmiBio Actions A.5 and A.6 resulted in an operational prototype of the sound-recording stations (SRS) and cost-effective solutions for data acquisition and data transmission to the central base station. During the third year of the AmiBio project implementation, sixteen sound-recording stations will be deployed at Hymettus Mountain and will start continuous monitoring of the acoustic activity of animals and the environmental parameters at the selected micro-sites. These micro-sites, selected during Action A.2 "Development of conservation action plan", cover the four most important habitat types at Hymettus, and are expected to provide statistical coverage of the Hymettus fauna. The overall architecture of the data communication framework is illustrated in Fig. 1. Specifically, for the needs of the AmiBio project we selected a communication concept which relies on existing infrastructure for 3G communications that provides coverage in the Hymettus area, and on existing IP network infrastructure. This design allows the implementation of a cost-effective solution that meets the requirements of the AmiBio project and offers a generic solution that can be easily adapted to other similar projects. The most significant advantage of this concept is its good portability and easy relocation of any sound-recording station to any desired micro-site for which coverage of 3G wireless networks is provided. This concept guarantees the lowest cost for equipment, the lowest maintenance cost, and offers the most convenient setup. For the implementation of this concept the AmiBio project benefits from a special memorandum for partnership with COSMOTE (www.cosmote.gr/). According to this agreement COSMOTE lends resources from its 3G wireless network for the needs of AmiBio project free-of-charge, which effectively makes COSMOTE an important partner in the project implementation.

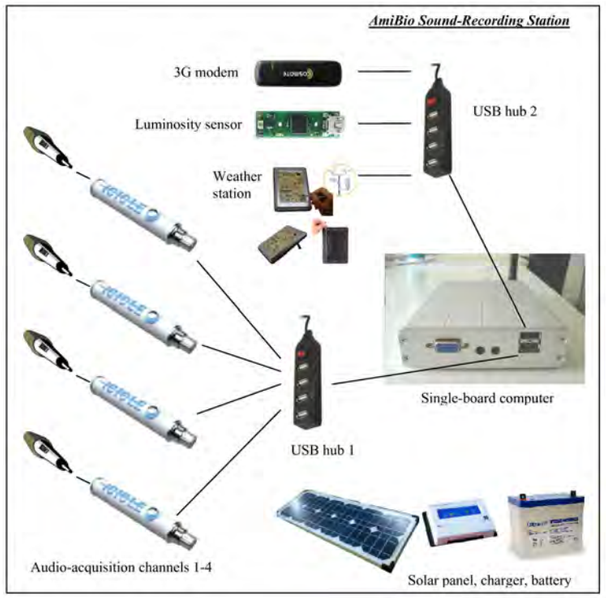

Fig. 2. *Overall architecture of the prototype sound-recording station (SRS)*

Each of the sixteen sound-recording stations is designed to guarantee real-time transmission of multichannel audio as well as information about the environmental parameters at the specific micro-site. The architecture of the sound-recording stations is modular, which makes the maintenance of the system cost-effective and reconfiguration of the hardware fast and convenient.

Fig. 2 shows the overall architecture of a sound-recording station. In brief, a miniature single-board computer, which is the core component of the sound-

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AmiBio inspires research on the Marginated Tortoise

by Moritz Konz, Lasse Lemm, Karl-L. Schuchmann, Olaf Jahn, Klaus Riede, and Vasilis Nomikos

During our biological inventories of sound-emitting animals in the Hymettus Mountains (see AmiBio Newsletter, July 2010) we locally discovered an exceptionally high number of adult individuals of the common, but scientifically little-known, Marginated Tortoise *Testudo marginata* (Fig. 3 and cover). Youngs, and particularly sub-adults, were represented only by remarkably few individuals. This intriguing population structure led to a detailed demographic field study beyond our AmiBio project.

Here, we summarize the first results of our research, conducted mainly by Moritz Konz and Lasse Lemm (Fig. 4a&b), two biology students from the Zoological Research Museum A. Koenig (ZFMK), Bonn, Germany. The field work was supported by the Association for the Protection and Development of the Hymettus Mountains (SPAY), Athens. Our aim was to determine the proximate factors causing such an unbalanced age distribution within a Marginated Tortoise sub-population at Ergani Valley (500 meters above sea level, c. 18.6 hectares). The valley, a former marble quarry, was partially refilled with rock debris and sand to facilitate future habitat-restoration efforts of SPAY. Nowadays, it is characterized by various grassland-dominated plateaus with different successional vegetation stages (Fig. 5). The westward exposure of the funnel shaped valley entrance supports a dry and hot spring and summer climate. This environmental condition favors an unusual species-rich Mediterranean flora and fauna.

The Marginated Tortoise, the largest European representative of its genus, is a characteristic and common species of the Hymettus massif, where it occurs from near sea level up to the top of the mountain. Its congener, the Hermann's Tortoise *Testudo hermanni*, is far less abundant in the Hymettus region and restricted to low altitudes at the base of the mountain. The environmental conditions (altitude, climate, sandy soils, and open to semi-open vegetation) of the Ergani Valley seems to meet the biological requirements of the species. The population of *T. marginata* surveyed during two study periods (April and June 2011) comprised 142 animals. For the Marginated Tortoise it is a well established fact that females enter their reproductive cycle after an age of 8 years. Thus, according to the number of shell plate rings, 89% of the Ergani subpopulation were adult individuals, estimated to be over 8 years old. The gender distribution was unequal, with 51% females and 38% males. The remaining 11% of the population represented sub-adults, 90% of which were under 5 years. In other words, the vast majority of the animals were in their reproductive age. Furthermore, on the basis of marked *T. marginata* individuals, our April observations indicate local movements of adult tortoises between the Ergani Valley and its vicinity. Hitherto it is unclear whether these movements can explain the odd gender ratio or the unusual age-class distribution found at Ergani. However, non-standardized observations in other parts of the Hymettus also revealed a very uneven ratio of young and adult individuals, with large tortoises much more often seen than smaller ones.

Surprisingly, all adult tortoises at Ergani had larger carapace sizes compared to published data of conspecifics of the same age class. This suggests good ecological conditions and abundant local food resources. The Ergani Valley also seems to be an important reproductive area for *Testudo marginata*. This idea is supported by several observations during our spring and summer study period. In April we recorded two copulating pairs, noticed by their loud low-frequency grunting and hissing sounds and in June we found several clutches in sandy soils.

The fact that some reptiles regularly emit sounds is not widely known. However, for the automated acoustic monitoring approach of AmiBio, this circumstance can make all the difference between detecting or overlooking a certain species (see AmiBio Newsletter, July 2010). Therefore, we made recordings of the hissing noises of several individuals of the Marginated Tortoise (Fig. 6). These sounds are often emitted by animals trying to intimidate a congener or a potential predator. Although it is not entirely sure yet whether these sounds are species-specific, so far, only *Testudo marginata* was recorded at most AmiBio monitoring sites.

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Fig. 3. *Single individual of Testudo marginata*

Fig. 4a&b. *ZFMK biology students taking measurements of tortoises*