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The Three Research Components of the 2011 Hearst Biodiversity Expedition to the Philippines

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The field research of the 2011 Hearst Biodiversity Expedition to the Philippines, was composed of three phases or components — a shallow-water component that explored the coral reefs of the Verde Island Passage primarily by snorkeling and SCUBA diving, a deep-water component on board the Philippine's government ship M/V *DA-BFAR* in the region of Batangas and Balayan Bays and the Lubang Islands that explored the deep benthic environment primarily by trawling and fish traps, and a terrestrial component by teams of botanists and entomologists that explored the forests of four mountainous regions in southern Luzon.

KEYWORDS: Phases or Components of the Expedition, Three Research Components, Shallow-Water Component, Deep-Water Component, Terrestrial Component

The Hearst Biodiversity Expedition to the Philippines took place between 24 April and 11 June 2011, and apart from the 1905/06 Galápagos Expedition, it was the largest expedition undertaken by the California Academy of Sciences in its 160-year history. The multidisciplinary expedition was divided into several components or phases, each composed of different complements of individuals in different geographic regions, which took place during time periods that did not necessarily overlap (Gosliner and Burke 2013). These components consisted of three research components (Figs. 1–10), educational outreach (Fig. 11A), and a large, well-attended symposium at the end of the expedition that was conducted at the University of the Philippines on 8 June 2011 (Fig. 11B). All of the components of the expedition not only included scientists, field researchers, media personnel, and educators from the California Academy of Sciences, but also from several institutions in the Philippines and the United States.

THE THREE RESEARCH COMPONENTS

The Shallow-Water Component

Figures 1–4

Shallow-water research took place on coral reefs (Fig. 2) and associated habitats primarily through the use of SCUBA using Nitrox technology (Fig. 4). Thirty-eight dive sites were explored in the Verde Island Passage region around Maricaban Island and the Calumpan Peninsula, Calatagan in Balayan Bay, and Puerto Galera on northern Mindoro (Fig 1A). Research activities took place between 28 April and 27 May, involving thirty-three individuals from a variety of institutions in the Philippines and the United States, including research biologists, aquarium biologists, students, dive safety personnel, and dive guides. SCUBA diving and snorkeling took place between surface waters and approximately 40 m in depth. One hundred seventeen dives were logged, with a wealth of marine invertebrates (Fig. 3) and fishes collected. All material was subsequently transported, curated, and housed at the California Academy of Sciences in San Francisco. Several diurnal dives and a night dive were conducted each day, with periodic rest periods scheduled for particular divers. Headquarters of the operation and field laboratories were located at Club Ocellaris on the Calumpan Peninsula just southwest of the village of Anilao. In addition, the inland fresh-

FIGURE 1. A. Map of research areas. Shallow-water component: Verde Island Passage, Puerto Galera, Calatagan, Taal Lake. Deep-water component: Luban Islands. Terrestrial component: 1 – Mt. Makiling, 2 – Mt. Malarayat, 3 – Mt. Banahaw, 4 – Mt. Isarog. B. Nautical chart showing the Lubang Islands group, the Verde Island Passage, and Taal Lake.

water environment of Taal Lake, a crater lake of volcanic origin (Figs. 10E–F), was also explored and fish and invertebrates were collected by a subset of researchers from the shallow-water operations.

Since 1992, varying degrees of severity regarding coral bleaching (Fig. 2F; compare with the appearance of unbleached scleractinians, figs. 2B, C, E) have been observed during field operations by Academy researchers on the coral reefs of the Verde Island Passage region. Coral bleaching is here defined as the sparsity or absence of zooxanthellae in normally zooxanthellate scleractinians. Prior to 1995, bleaching in scleractinian corals was only occasionally encountered, the incidents of detection ranging from rare to infrequent. By contrast, after 1995, observation of coral bleaching was far more frequent. Reflecting on this, the mid-1990s can be regarded as a pivotal period concerning changing conditions responsible for the prevalence of coral bleaching in the region. A significant variance in degree of bleaching can be seen if one compares the severe bleaching incident of 2010 with observations made during the Hearst expedition in 2011. A major bleaching event occurred in mid-2010 throughout much of the tropical Indo-west Pacific from the eastern Indian Ocean to the Philippines (Sundt 2010). By May through June 2011, during the Hearst expedition in the Verde Island Passage, bleaching was occasionally observed as isolated examples, but the severe conditions of the previous year and any residual effects of a mass mortality or coral damage were not observed.

The Deep-Water Component

Figures 1B, 5–6

The second marine research component explored the deep sea benthos in the vicinity of the Lubang Islands to the west of the Verde Island Passage region of the shallow-water component. This phase took place took place during an eight day period form 29 May to 5 June 2011, on board the government of the Philippines research ship, M/V *DA-BFAR*. Sampling of the biota from the sea bottom was conducted between 60 and 2195 meters in depth by trawl nets that included standard trawls, otter trawls and bottom trawls. Fish traps were also employed, which were used at night and brought up on deck each morning before the day's trawling operations commenced. Participants included a large compliment of biologists and marine resource managers from BFAR (Bureau of Fisheries and Aquatic Resources), University of the Philippines, National Museum of the Philippines, as well as the California Academy of Sciences (Departments of Ichthyology and Invertebrate Zoology and Geology).

One unsuspected and unfortunate outcome of the benthic collecting during this phase was the prodigious amount of sunken plastic material and other un-decomposed garbage that was brought up from the sea floor in the majority of trawls. In some instances, the amount of plastics was far greater than that of the biotic material that was encountered.

The Terrestrial Component

Figures 1A, 7–10

It is generally accepted that the Philippine archipelago has had an extensive period of human occupation dating back to the late Pleistocene (Jocano 2001). Primary forests are now mostly restricted to higher montane regions, such as on the upper slopes of volcanic peaks. Four of these regions in southern Luzon were selected for field research as part of the Hearst biodiversity expedition: Mt. Makiling, Mt. Malarayat, Mt. Banahaw, and Mt. Isarog.

The terrestrial research component was conducted from 6 May to 5 June 2011 by four groups of researchers from the California Academy of Sciences along with colleagues from the University of the Philippines and Pusod (a non-profit organization whose mission is to protect and enhance

the ecosystems of the Philippines). The groups worked separately for the most part and consisted of a botany section (mosses and flowering plants), an entomological section (primarily spiders and millepedes), herpetologists led by Cameron Siler and Rafe Brown from the University of Kansas, and mammalogists from the University of the Philippines.

Acknowledgments

Gratitude is here extended to the chief scientists for each of the three research components of the expedition: Terrence Gosliner (shallow-water component and overall expedition chief scientist), Rich Mooi (deep-water component), and Peter Fritsch (terrestrial component), to all the participants and support staff that made the expedition a reality, and for the generous gift by Margaret and William Hearst that made it all possible. Identifications of the amphibians and reptiles (Figs. 10A–D) were graciously provided by Dr. Rafe Brown (Univ. Kansas).

The photographs reproduced in this article are by members of the expedition and are in the Hearst Biodiversity Expedition archives at the California Academy of Sciences.

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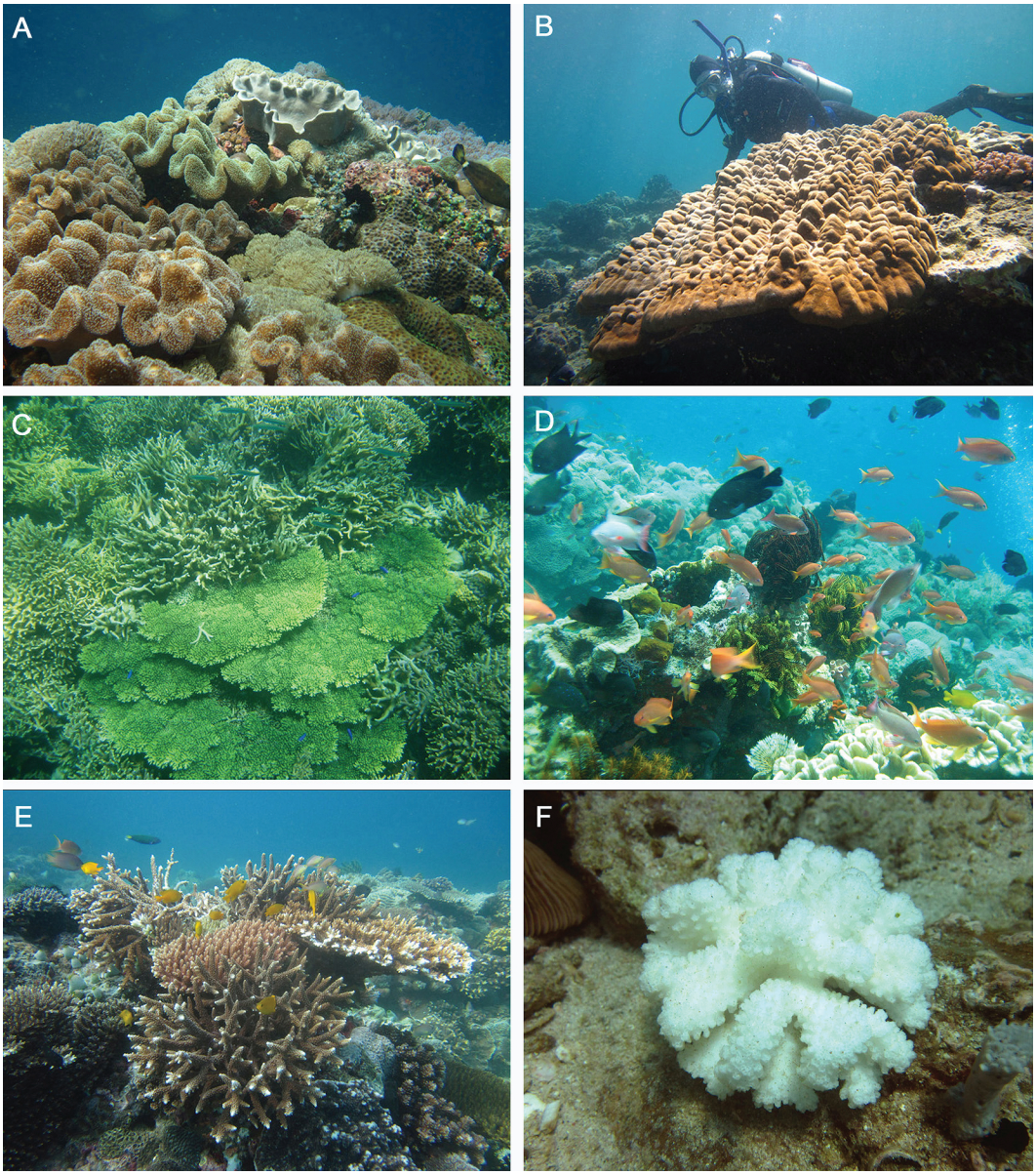

FIGURE 2. Shallow-water component. Underwater photographs of coral reefs. A. Reef area dominated by various species of soft corals. B. A large coral head of the scleractinian, *Porites* sp. C. Dense populations of *Acropora* spp. D. A shallow-water coral reef slope. E. Reef area dominated by hard corals, primarily *Acropora* spp. F. An example of coral bleaching in *Pocillopora* sp. Photos by G. C. Williams.

FIGURE 3. Shallow-water component. Underwater photographs of marine invertebrates. A. Barrel sponge, *Xestospongia testudinaria*. B. Soft coral, *Umbellulifera* sp. C. Cerianthid tube anemone. D. Dorid nudibranch, *Chromodoris magnifica*. E. Mantis shrimp, *Odontodactylus scyllarus*. F. Fire Urchin, *Asthenosoma varium*. Photos by G. C. Williams.

FIGURE 4. Shallow-water component, marine field research, Verde Island Passage. A. Kirby's dive site, Caban Island. B. A returning dive boat, Calumpan Peninsula. C. Dive boat approaching Devil's Point dive site, Maricaban Island. D. Divers and dive boat, Basketball dive site, Calumpan Peninsula. E. Diver on a scleractinian-dominated reef flat, Gemou Point, Maricaban Island. F. Dive boats at sunset, Calumpan Peninsula. Photos by G. C. Williams.

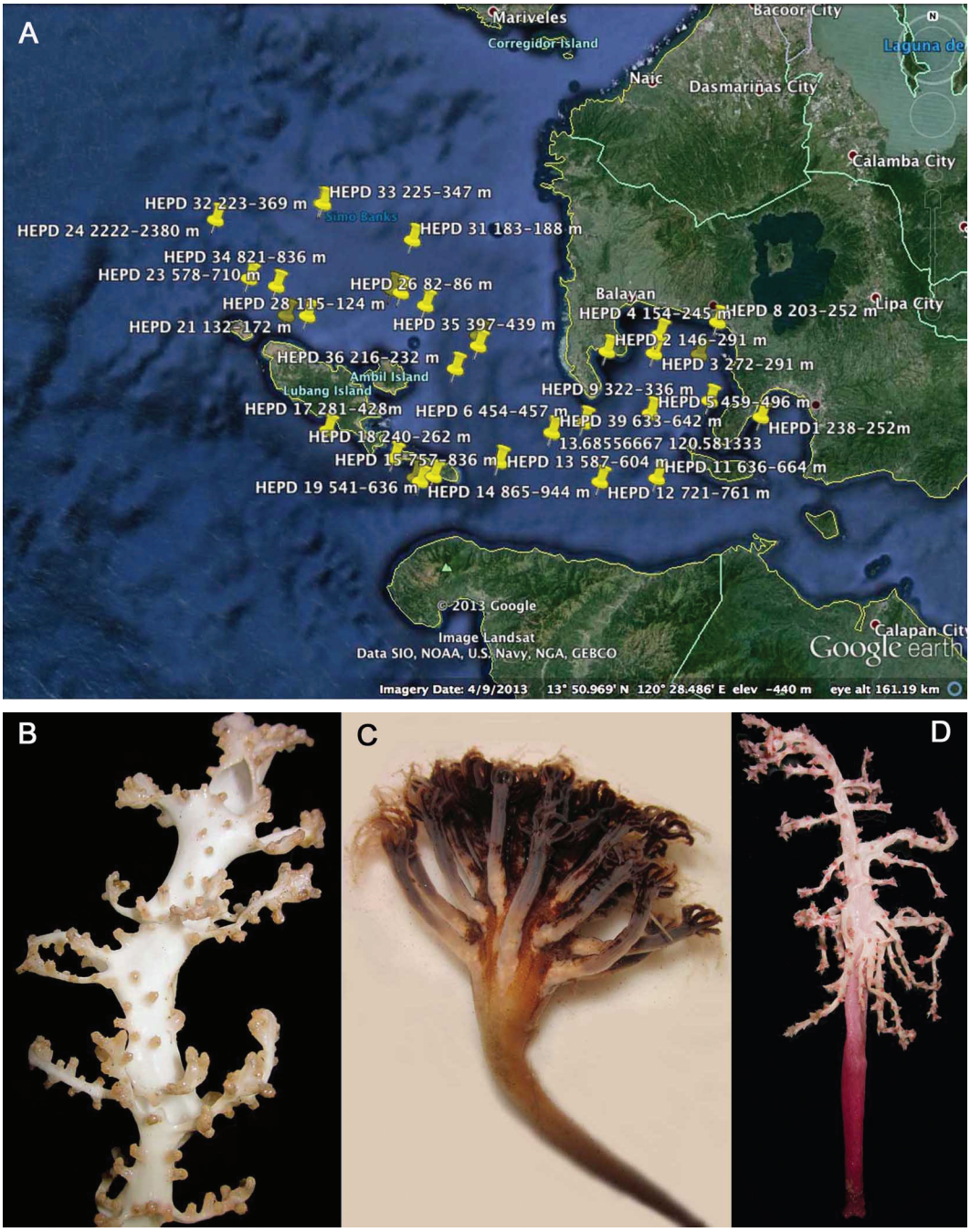

FIGURE 5. Deep-water component, Verde Island Passage and Lubang Islands. A. Map of the deep-sea collection stations by HEPD station number (Hearst Expedition Philippines Deep-sea) and depth; information for Google map by T. M. Goslin-er. B. Scleraxonian gorgonian octocoral, *Solenocaulon* sp. (HEPD 26). C. Sea pen (pennatulacean), *Umbellula* sp. (HEPD 9). D. Soft coral, *Chironephthya* sp. (HEPD 26). Photos by G. C. Williams.

FIGURE 6. Deep-water component, Verde Island Passage and Lubang Islands. A. Giant isopod, *Bathynomus kensleyi*. B. Pleurobranchoidean opisthobranch, *Pleurobranchella nicobarica*. C. Ambil Island, Lubang Islands Group. D. Sorting trawl samples. E. Emptying the trawl net on the deck of M/V *DA-BFAR*. F. Collecting plankton samples. G. The research ship M/V *DR-BFAR*. Photos by G. C. Williams.

FIGURE 7. Terrestrial component – Botany. A. Mt. Banahaw de Lucban; photo by D. S. Penny. B. Primary forest, Mt. Isarog National Park; photo by P. W. Fritsch. C. Botanical research team on Mt. Isarog (left to right, Isarog National Park administration representative, Steve (field/lab assistant for Dr. Eduino Fernando), Jen Dimas-Edrial (project manager for Pusod — a non-profit organization whose mission is to protect and enhance the ecosystems of the Philippines), Jin (field assistant and tree-climber for Dr. Eduino Fernando); Darin S. Penneys, Peter W. Fritsch; photo by D. S. Penneys. D. *Vaccinium* sp, family Ericaceae; photo by P. W. Fritsch. E. *Rafflesia maniliana*, family Rafflesiaceae. F. *Medinilla teysmanii*, family Melastomataceae; photo by D. S. Penneys.

FIGURE 8. Terrestrial component – Entomology. A. Entomological research team (left to right: [standing] Hanna Wood, Orlando "Daddyboy" Eusebio, Charles Griswold, Mark Yngente, Sheryl "Sheng" Yap, and Vanessa Knutson; [kneeling] Veverle San Juan and Natalia Chousou Polydouri). B. Web of *Nephila* (Araneae, Nephilidae), UP Los Banos. C. Jumping spider (Araneae, Salticidae). D. Centipede (Chilopoda, *Scolopendra*), IP Los Banos. E. "Vinegaroon" (Arachnida, Thelephonida). F. Unidentified scorpion. Photos by members of the Hearst Expedition.

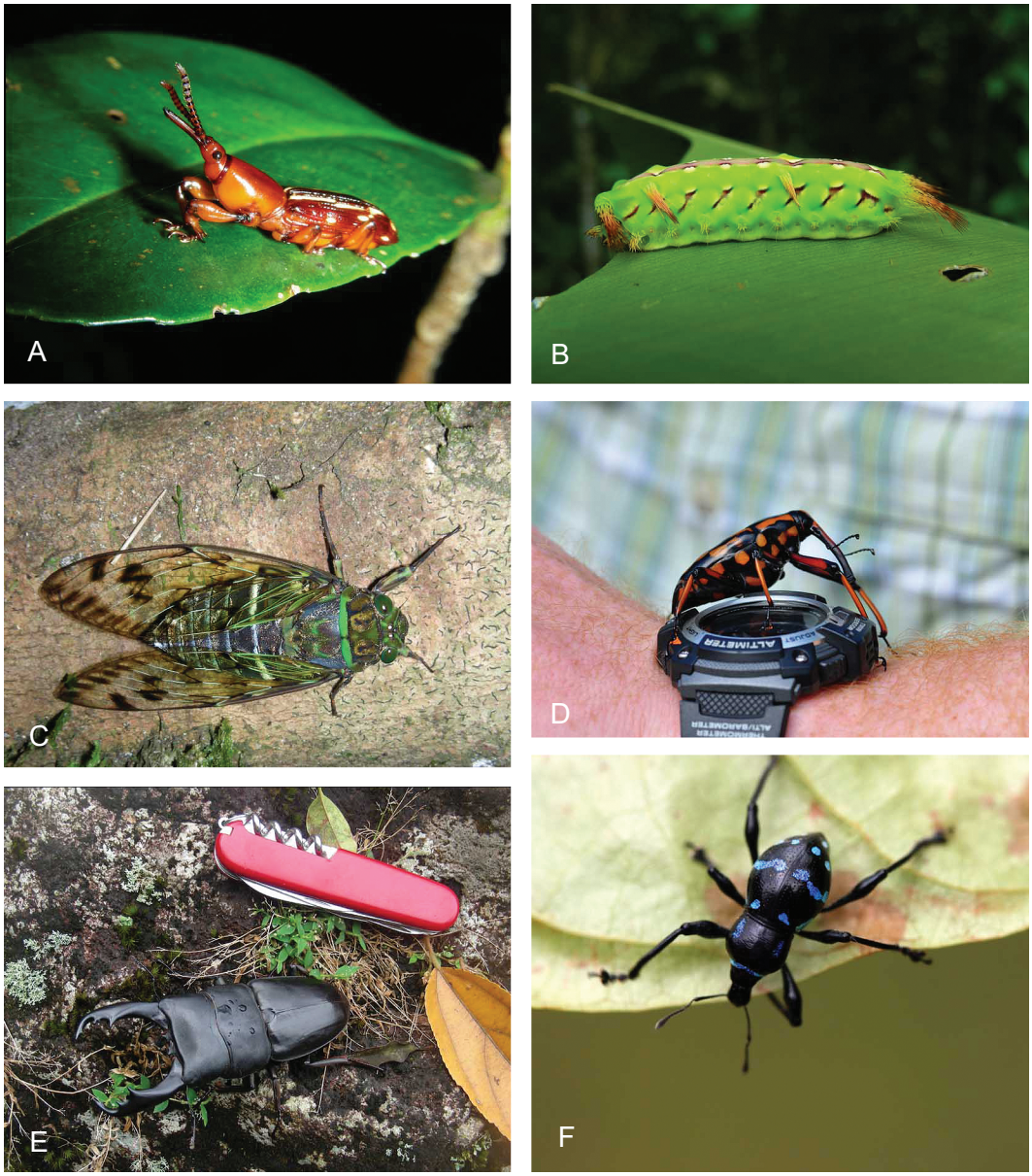

FIGURE 9. Terrestrial component – Entomology. A. Stick weevil (Coleoptera, Brentidae). B. Caterpillar (Lepidoptera, *cf* Limacodidae). C. Cicada (Homoptera, Cicadidae). D. Weevil (Curculionidae, Coleoptera, Mt. Banahaw. E. Stag beetle (Lucanidae, Coleoptera). F. :Easter egg" weevil (Platyrhynchine, Curculionidae, Coleoptera), Mt. Banahaw. Photos by members of the Hearst Expedition.

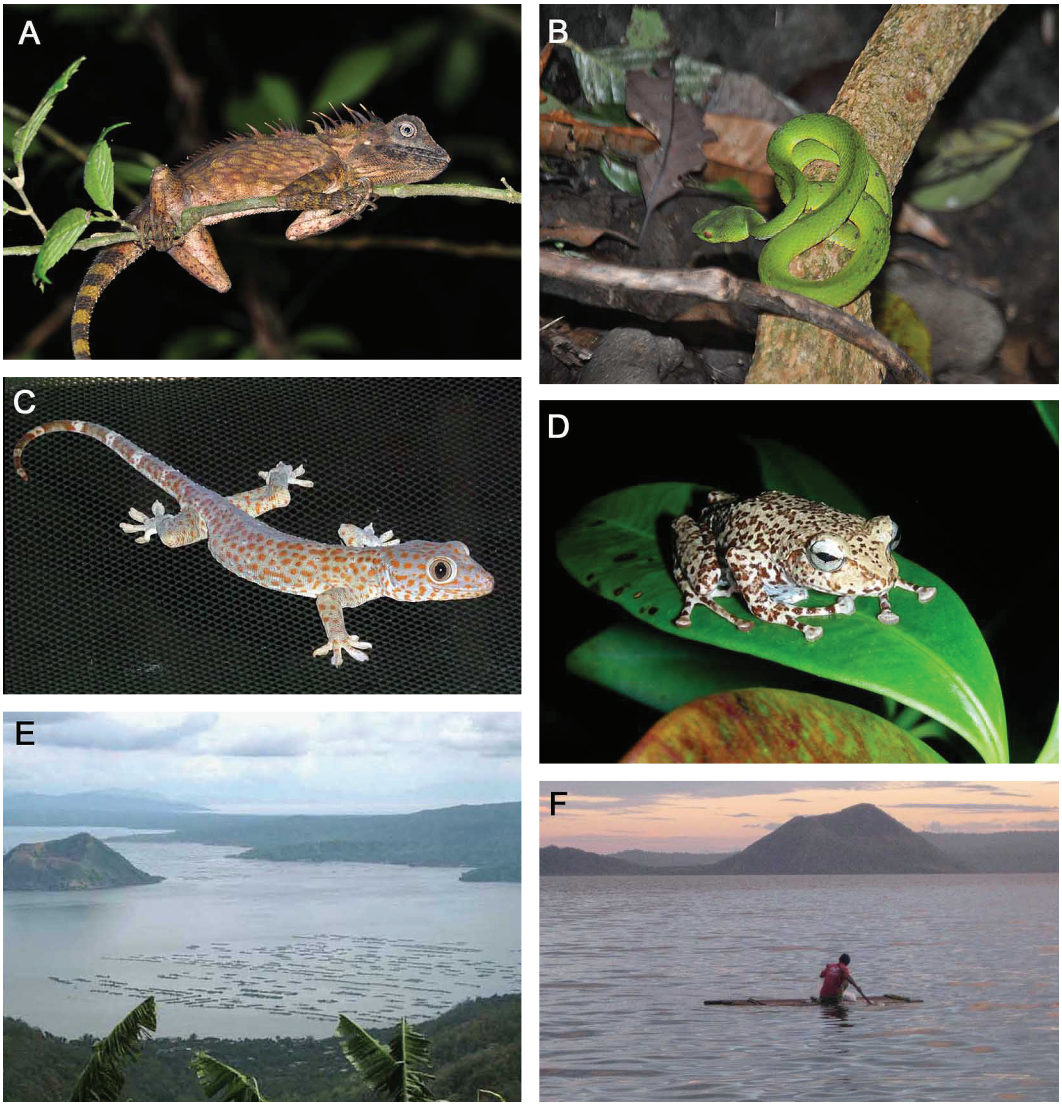

FIGURE 10. Terrestrial component – Herpetology; and Taal Lake. A. Agamid lizard, *Gonocephalus sophiae*. B. Pitviper snake, *Trimeresurus* (*Parias*) *flavomaculatus*. C. Gecko lizard, *Gecko gecko*. D. Tree frog, *Platymantis isarogi*. E–F. Taal Lake showing the central volcanic peak within the surrounding inundated caldera. Photos by members of the Hearst Expedition.

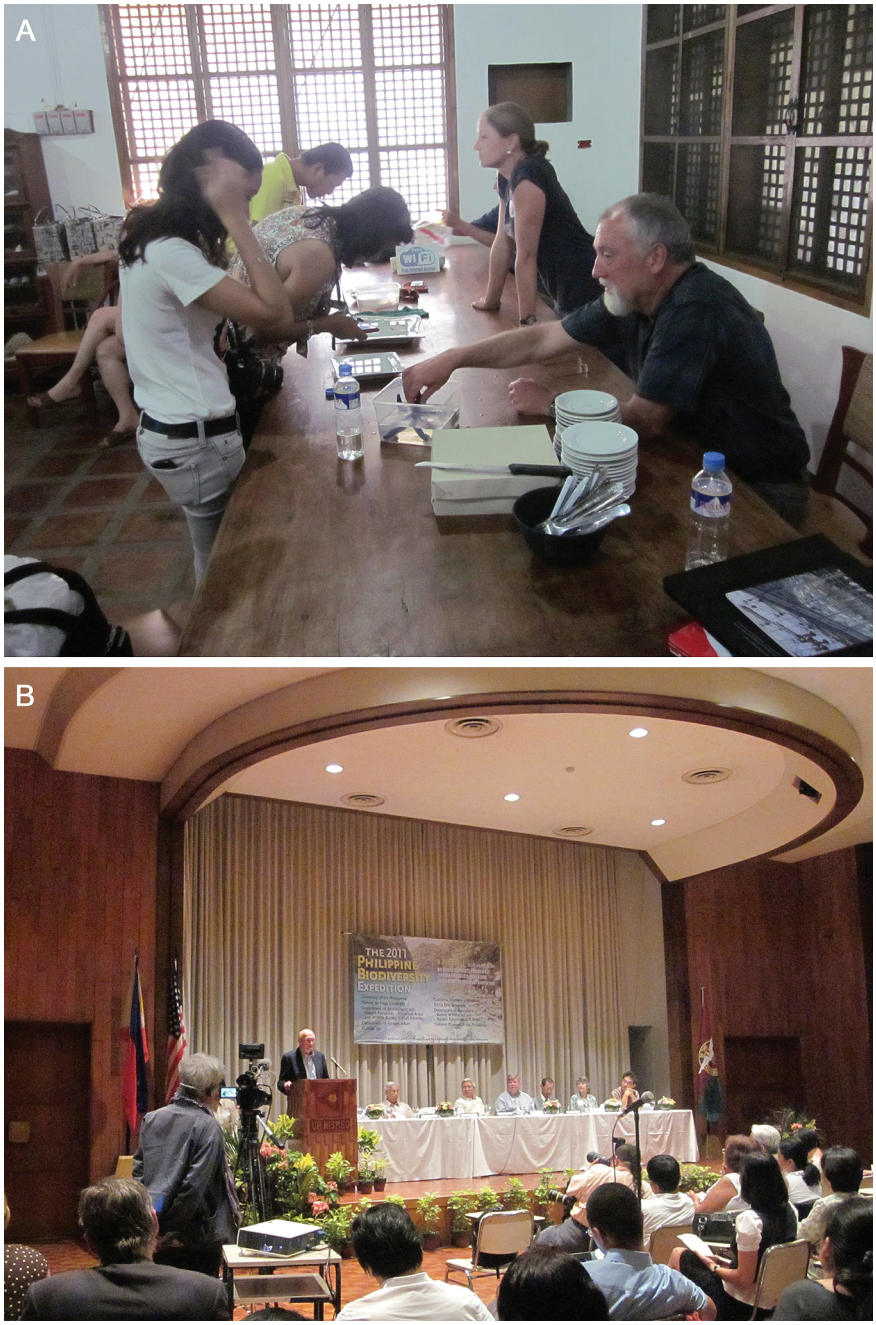

FIGURE 11. A. Educational outreach, Calatagan, 19 May 2011; Academy scientists with Philippine sea scouts and Conserve and Protect (CAP) — a local community oceans conservation foundation; photo by T. M. Gosliner. B. The 2011 Philippine Biodiversity Symposium, University of the Philippines, Manila, 8 June 2011.; photo by G. C. Williams.