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PEET: Biogeography, Morphology, and Molecular Systematics of Cumaceans: Training Taxonomists for the 21st Century

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Title:
PEET: Biogeography, Morphology, and Molecular Systematics of Cumaceans: Training Taxonomists for the 21st Century

Project Participants

Senior Personnel

Name: Watling, Leslie
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Kornfield, Irving
Worked for more than 160 Hours: Yes
Contribution to Project:

Post-doc

Graduate Student

Name: Gerken, Sarah
Worked for more than 160 Hours: Yes
Contribution to Project:
Had a Research Assistantship; went on expeditions, sorted samples, is describing new taxa.

Name: Haye, Pilar
Worked for more than 160 Hours: Yes
Contribution to Project:
had a Research Assistantship; worked on developing molecular techniques (primers, etc.) for phylogenetic analysis.

Undergraduate Student

Name: Goetz, Amber
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Borberg, Jenna
Worked for more than 160 Hours: Yes
Contribution to Project:
participated as a summer intern from UC Santa Barbara

Name: Gross, Jennifer
Worked for more than 160 Hours: Yes
Contribution to Project:
was summer intern from U. Alaska Anchorage

Name: Patel, Charmaine
Worked for more than 160 Hours: Yes
Contribution to Project:

Technician, Programmer

Other Participant

Research Experience for Undergraduates

Organizational Partners

Other Collaborators or Contacts

Have worked with and are training two persons not funded by this project:
1. Iorgu Petrescu, Gigore Antipa Museum, Bucharest, Romania.
2. Saowapa Angsupanich, Prince of Songkla University, Hat Yai, Thailand. Two papers with Saowapa were published in 2002.
Have also served as reviewer and advisor on cumacean manuscript issues for Richard Heard, Gulf Coast Marine Lab., MS, and Ute Muhlenhardt-Siegel, University of Kiel, Germany.

Activities and Findings

Research and Education Activities:

Monographic Research:
Specimen Collecting: The last of our PEET expeditions, this year to New Zealand, was completed in 1999, just before the grant ended. A total of two weeks was spent collecting at six sites, three on the South Island and three on the North Island. The North Island sites were located north of Auckland and thus were in a different biogeographic province (Auckland) than those from the South Island (Cookian). In addition, as opportunities presented themselves, we were also able to collect cumaceans in the British Virgin Islands, Thailand, East Africa, and Great Britain. In all cases, specimens were preserved in 95% ethanol so that they could be used for molecular genetic analyses.

Specimen Processing and Identification: The specimens collected last year in the Gulf of Mexico have been sorted but are not yet identified. By the end of our 4th year all the Chilean and Gulf of Mexico material will be identified, and in the cases where we have sufficient material, processed for molecular data. Other material, obtained on loan from the Museum of Victoria, collected in the Bass Strait, Australia, has been sorted and those species in families of interest have been identified. Descriptions have been prepared for 26 new species, most of which will go into the monograph being produced by one of our students (Sarah Gerken) for her dissertation. Descriptions of new Chilean taxa are being prepared by another of our students (Pilar Haye) as part of her general systematic training.

Molecular analysis: We continue to concentrate our efforts on the elucidation of the relationships among the families of Cumacea. Molecular studies have principally been conducted by Pilar Haye. We have obtained 750 base pairs of sequence from the mitochondrial gene Cytochrome Oxidase I (COI) for at least one representative genus of each of five families (sequence in now available for a total of 13 taxa). This gene has shown to be relatively informative at the level of amino acid substitutions, enabling us to generate phylogenetic hypotheses of the familial relationships within the Order. Nucleotide sequences have been deposited in GenBank under accession numbers AF069764, AF061781, AF061782, AF137510-20. Current molecular studies involve optimizing additional primers that amplify other regions of the mitochondrial genome; we have successful amplified DNA from other crustaceans and arthropods using these primers.

Findings:

Monographic Research:
Number of new taxa: Material from the Bass Strait and other locations outside of Australia produced 45 new species in the Family Gynodiastylidae. These (along with other material recently collected in Australia by the Museum of Victoria) were described as part of a monograph produced by Sarah Gerken for her dissertation. In all her monograph included the 45 new species, 6 new genera, and 58 previously described species. All were coded in DELTA and those files will soon be made available on the web site, Crustacea.net in the form of an interactive key. New species from our Chilean collections of 1997 are being described by Pilar Haye.

The Gulf of Mexico expedition produced about 30 species in all, most of the new taxa were from the west Florida shelf and the inner shelf off Texas. The slope samples produced few species, perhaps due to the presence of an oxygen minimum layer beginning at about 700 m. The New Zealand material is just now being sorted and so far is quite rich in species. To date, the New Zealand fauna has 35 known species and we expect our material, along with material borrowed from the Te Papa Museum (Wellington) to double the number of species in the New Zealand fauna.

Molecular systematics: At the ordinal level, two CO1 amino acid substitutions occur in all cumaceans sequenced to date and thus appear diagnostic for the group. Our cladistic analyses suggest that the loss of the articulated telson occurred only once in the Order. Additional molecular characters are required, but all data and analyses to date suggest that the non-telson bearing groups are more closely related to each other than to the telson bearing groups (see Tree 1 in the attached figure). Within the non-telson group, two families (Nannastacidae and Leuconidae) share four amino acid synapomorphies. Estimates of CO1 sequence divergence have suggested that some aspects of the formal taxonomy will merit revision. For example, divergences between some species within the family Diastylidae are as large as those observed between different families of cumaceans.

In a parallel study, we have completed a phylogenetic analysis of mole crabs in the genus Emerita (Decapoda: Anomura: Hippidae) using DNA sequences from the CO1 and 16s rRNA regions of mtDNA. In virtually all analyses, Emerita analoga forms a distinctive clade external to all other congeners; it possesses a number of unique apomorphies. E. analoga has a greater genetic distance to any congener than is observed for any other pairwise comparison in the genus. In fact, the level of sequence divergence is comparable to that noted for comparisons with the Hippa pacifica, the confamilial outgroup. The distinctive nature and divergence of E. analoga suggest interesting biogeographic and molecular hypotheses. Relationships among these taxa are summarized in the accompanying figure (Tree 2).

Training and Development:

The primary objective of the PEET Program is to train a new generation of systematists. Toward that end we had two Ph.D. students working on this project. Both have taken the course work and completed the lab work which will give them the tools needed to attack systematics problems from a modern perspective. This includes the ability to illustrate and describe new taxa as well as to use both morphological and molecular tools to assess the biogeographic and phylogenetic history of the group.

In addition, we have had several undergraduate students working in our labs. They have experienced first-hand the excitement of systematics-based research (one undergraduate student went on our Gulf of Mexico research cruise) and have seen how the specimens we collected can be used to understand the history of life on this planet.

Outreach Activities:

Watling did a voice overlay on the beauty and importance of habitat and biodiversity for a N.Y.-based performance artist who wrote a play which was performed by local teenagers. It was performed at the Round Top Center for the Arts during the summer tourist season here in coastal Maine.

Watling also recorded for the National Public Radio program, Ocean Report, a 1 minute story on cumaceans, under the common name of 'comma shrimps.'

Journal Publications

Gerken, S. & L. Watling., "Diastylis tongoyensis, a new diastylid (Crustacea: Cumacea) from the northern central coast of Chile, with an amendment to the description of Diastylis crenellata Watling & McCann 1997.", Proceedings of the Biological Society of Washington, p. 857, vol. 111, (1998). Published

Watling, L. & S. Gerken, "A new species of leuconid (Crustacea: Cumacea), Leucon (Crymoleucon) n°rrevangi, from the Faroe Islands", Sarsia, p. 437, vol. 84, (1999). Published

Hessler, R.R. & L. Watling, "Les Peracarides: un groupe controverse", Memoire de l'institute Oceanographique, Monaco., p. 1-10, vol. 19, (1999). Published

Gerken, S., L. Watling, A. Klitgaard, "Some contumacious Cumacea from Arctic waters.", Journal of Crustacean Biology, p. 31-43, vol. 20, (2000). Published

Petrescu, I. & L. Watling, "Revision of genus Americuma Watling 1991 with the redescription of Styloptocuma heardi (B?cescu, 1979) based on neotype material. (Crustacea: Cumacea).", Travaux du Museum National d'Histoire naturelle "Grigore Antipa", p. 299, vol. 41, (1991). Published

Watling, L. & S. Gerken, "Two new Cumacean (Crustacea) species from the deep South Atlantic.", Zoosystema, Paris., p. 661-9, vol. 21, (1999). Published

Gerken, S. & L. Watling, "Cumacea (Crustacea) of the Faroe Island Region.", Frodskaparrit, p. 199-227, vol. 47, (1999). Published

Gerken, S., "The Gynodiastylidae (Crustacea: Cumacea)", Memoirs of Museum Victoria, p. 1-276, vol. 59, (2001). Published

Gerken, S., "A new species of Vemakylindrus (Crustacea: Cumacea: Diastylidae) from California.", Proceedings of the Biological Society of Washington, p. 419-425, vol. 115, (2002). Published

Gerken, s. & H. Ryder., "Campylaspis rex, a new spcies (Crustacea, Cumaea) from New Zealand", Proceedings of the Biological Society of Washington, p. 412-418, vol. 115, (2002). Published

Haye, P., I. Kornfield & L. Watling, "Molecular insights into Cumacean family relationships", Molecular Phylogenetics and Evolution, p. , vol. , ( ). Submitted

Watling, L. & S. Angsupanich., "Procampylaspis andamanensis, (Crustaccea, Cumacea) first record of the genus from the Indo-Polynesian biogeographic province.", Phuket Marine Biological Center Special Publication, p. 33-40, vol. 23, (2002). Published

Watling, L. & S. Angsupanich., "Cumacea of Thailand û an annotated list.", Phuket Marine Biological Center Special Publication, p. 41-51, vol. 23, (2002). Published

Books or Other One-time Publications

Watling, L., "Toward understanding the relationships of the peracaridan orders: the necessity of determining exact homologies.", (1999). Book, Published
Editor(s): F.R. schram & J.C. von Vaupel Klein.
Collection: Crustaceans and the Biodiversity Crisis.
Bibliography: Brill, Leiden.

Web/Internet Site

URL(s):

http://nature.umesci.maine.edu/pub/cumacea.html

Description:

This site provides an overview of our entire PEET project with emphasis (to date) on morphology. A key to the families of the Order is provided as well as a comprehensive database on the distribution of individual taxa. We are in the process of revising this database to include material recently collected as well as additional locations for included taxa.
Larger data sets, for example, those produced by the program DELTA, will be stored as interactive keys on the web site "www.crustacea.net". There was no way to add this as an additional url in this reporting system.

Other Specific Products

Product Type: Data or databases

Product Description:

World Cumacean Database. Includes fields for type locality, disposition of type specimen, other localities collected (with lat. & long. data where possible), above-species levels of classification, among others.

Sharing Information:

the database is in Access, and when fully updated and corrected will be put on our web site. It will also be made available on CD-ROM.

Product Type: Physical collection (samples, etc.)

Product Description:

Collection of marine crustaceans preserved in 95% ethanol so they can be used for molecular phylogeny studies. This collection includes material from all the expedition sites as well as opportunistic collection areas.

Sharing Information:

We will try to catalog/database this collection and post its existence on our web site. We will send specimens to any researchers who would like to use the material for DNA extraction.

Product Type: PDF files of taxonomic reprints on CD

Product Description:

PDF files of taxonomic reprints scanned and stored on CR-ROM. Will eventually encompass all papers describing species of cumaceans.

Sharing Information:

Files are copied to CD-ROM and sent to anyone who requests them.

Contributions

Contributions within Discipline:

We have two major contributions for our discipline:
1. Our expeditions have filled in major biogeographic gaps, for which there were no species recorded.
2. our molecular work has resulted in the development of specific primers which can be used to investigate the molecular phylogeny of this group.

Contributions to Other Disciplines:

We know from personal experience that physical sciences people don't believe this, but, we have to say that cumaceans have such great fidelity to water mass types that they could be used as intermediate-term (one or two generations, perhaps 1-3 years) indicators of hydrographic conditions. We suspect that this is generally true for deeper water (beyond the mid-shelf) dwelling benthos.

Contributions to Human Resource Development:

So far none of our undergraduates have chosen to take up systematics as a career choice, although Jennifer Gross was working at U Hawaii in the lab of Julie Bailey-Brock identifying polychaetes for two years. However, two of our summer interns (Jennifer Gross and Heidi Ryder) have each described a new species with one of our graduate students (Sarah Gerken). All who have worked in our labs have developed an appreciation for the challenges posed by systematic research. This should ultimately help to change the perception of systematics in the broader community.
Jennifer Gross is now in a graduate degree (M.S.) program with Cindy Van Dover at VIMS.
Sarah Gerken (Ph. D. student) has a tenure-track faculty job at the University of Alaska-Anchorage.
Pilar Haye (Ph.D. student)has a tenure-track faculty job at Universidad Catolica del Norte campus in Coquimbo, Chile.
Exequiel Gonzalez (Ph.D.), while not formally supported on this project, but who worked in my lab with the other students, is a tenured faculty member also at Universidad Catolica del Norte in Coquimbo, Chile.

Contributions to Resources for Research and Education:

Contributions Beyond Science and Engineering:

Categories for which nothing is reported:

Organizational Partners

Contributions: To Any Resources for Research and Education

Contributions: To Any Beyond Science and Engineering