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## Report of the Study Group on Integrated Morphological and Molecular Taxonomy (SGIMT)

by correspondence



**ICES**

International Council for  
the Exploration of the Sea

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l'Exploration de la Mer

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## Executive summary

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Since its inception by the WGZE and set up at the ASC in 2009, this small Study Group has been finding its way in a complex area over the past two years. During its first year of existence, SGIMT carried out a number of discussions among concerned scientists and at Expert Group meetings. During 2010, informal discussions continued, but no meeting was convened and limited progress was made on the ToRs, due to circumstances beyond the control of the Chair and members.

The SG's initial efforts have focused on exploring the territory and associated needs and resources. In addition to the ToRs, SGIMT is focused on addressing significant issues raised by individuals responding to a SGIMT questionnaire, including representatives of 26 ICES Expert Groups and another 27 individuals representing their own and/or their institute and project interests. The primary issues highlighted by the questionnaire respondents are summarised as follows:

- 1) There is fundamental need for taxonomic expertise to identify species in time-series monitoring of plankton, benthos and fisheries surveys; to validate acoustics estimates; and for studies of food webs and trophic interactions, biodiversity, contaminant effects, bioassays, parasitology, and many more.
- 2) Across the breadth of ICES Expert Groups, scientists are working with a huge range of marine organisms from microplankton through benthos, fish and marine mammals and birds, and in many environments and studies.
- 3) New policy demands and directives (Ecosystem Approaches, MSFD/GES descriptors, assessments and ICZM spatial plans etc.) are increasing demand for taxonomic expertise, while also requiring an increased diversity in species to be surveyed /studied and in the degree of integration between science disciplines doing so.
- 4) Data integrity is at risk if standards of taxonomic identification and nomenclature are not set and maintained. There are international projects developing these data and standards.
- 5) Nomenclature standards and taxonomic resources – such as species keys and ID guides - are not readily nor publicly available and/or they do not cover the extended regions and ranges of species that modern surveys and research require. Descriptions of less common species and developmental stages are often lacking or unavailable, and may sometimes be impossible without molecular genetics.
- 6) Molecular methods are developing fast and are widely appreciated as key to solving problems in species ID and to providing new insights into the dynamic processes in pelagic ecosystem, including trophic interactions, speciation and divergence of metapopulations, as well as understanding of organism - environment interactions and reactions to stressors. However many molecular scientists and many field ecologists have difficulties in establishing collaborative studies. Cost is an issue, as is consistency over time, due to rapid advances in molecular methods and approaches.
- 7) Training and knowledge transfer are seen as key to expanding taxonomic expertise, resources and availability. True taxonomists are very scarce. In recent year, most species have been described by ecologists and technicians, who are qualified to identify species and determine species' abun-

dances in samples, but may lack depth of knowledge in taxonomy. Expertise in species identification is often scarce, hard to learn and undervalued, and requires access to appropriate identification guides and keys, expert mentoring, and considerable practical experience.

- 8) Many within and out with ICES Expert Groups have said they are willing to help ICES and SGIMT address these problems and issues.

Taxonomy is critical to any national and international efforts that adopt ecosystem approaches to assessment and management of ecosystems, ecosystem services and species diversity and impacts on these. Such efforts must be achieved against a background of global development and changes in demography, climate and economics. Marine scientists in ICES Expert Groups are involved in marine surveys, monitoring and research on all marine phyla from microbes to whales and from coastal waters to deep seas. There is international acknowledgement of the decline and increasing need for taxonomic science, and for initiatives to fund development and training for a new generation of scientists in these fundamental skills and knowledge of taxonomy enhanced by modern developments in molecular chemistry and genetics. ICES can help to facilitate such developments through its access to knowledge in expert groups and through its advisory role.

New policies and pressures have arisen from scientific consensus and political necessities: Pressures include fishing, aquaculture, extraction of energy or aggregates, and impacts of contaminants, climate change, ocean acidification, species' range shifts and introductions, etc. Ecosystem approaches are now policy imperatives and the need is growing for indicators and assessments of ecosystem health, understanding of food webs and species adaptation, preservation of biodiversity, and awareness of impacts on key communities and species, critical habitats, endangered species, etc. All of these issues require increased and inclusive taxonomic expertise, often in addition to that required in traditional studies and surveys of contaminant impacts and harvested stocks.

Different species react to and are affected by stressors in different ways. Changes in community structure, species diversity, and species phenology and productivity will affect food webs, trophic relationships, and transfers and cycles of nutrients, chemical elements, energy and biological production. Observation and recognition of these impacts all require species-level taxonomic analysis of the pelagic ecosystem. If taxonomic skills and training are allowed to decline, our capacity to observe and recognize sensitivities and effects on ecosystems and food webs will be severely compromised.

The integration and standardization of taxonomic nomenclature and expertise are the focus of several recent or ongoing international programs and initiatives, including: GBIF, CoML, EoL, Species2000, WoRMS, ERMS, ITIS, EDIT, PESI and ETI. ICES experts and their colleagues have been or are now involved in these projects – frequently in leadership roles – and the ICES community now includes many experts who are active in taxonomic or taxonomy-dependant research. For ICES managers and experts the question is how best to cooperate or integrate with these networks and ensure full coordination and access to the resulting data and information to add value to ICES products and advice. “Getting taxonomy right” must be a major concern for data management, since uncertainties, confusion and errors in taxonomic analysis of groups and species seriously degrades standards and data quality; while making compilation and comparisons difficult. **In sum, it is imperative that ICES**

nations and data managers have access to, and use, the most up to date and standardised taxonomic nomenclature.

ICES should request species lists from expert groups, notably the WGPME, WGHABD, WGZE, BEWG, WGFE and WGBIODIV, these lists should be compared / checked against WoRMS to provide standard nomenclature and accepted synonyms using the new tool (<http://www.marinespecies.org/aphia.php?p=match>).

**These expert-confirmed lists and standards should also be used to standardise nomenclature across ICES data holdings and products.**

It is not always possible to determine taxa to species level due to practical limitations and logistics of sampling, analysis or available expertise and facilities. Often observations are of groupings at higher taxonomic levels or employ common names. These too can lead to confusion and incompatibility among datasets or in data comparisons. **It is important that projects and surveys standardise and include their choices of species ID levels in metadata relating to each study. Access through the ICES data centre to recommended nomenclature, existing standards or previously used and corrected “species” lists would be a useful resource for ICES and other scientists.**

New molecular methods have yielded new insights and have enormous potential for taxonomic research and applications. It seems likely that taxonomy and phylogeny of some groups will be greatly revised, with the addition of molecular and biogeochemical characters to ID species, assess abundance, and examine evolution, speciation, cryptic species and species' adaptive capacities. Additionally, the 'omics' (i.e., genomics, metabolomics, transcriptomics) will allow new insights into the underlying processes that define species' physiology, function, (meta)population dynamics, and responses to environmental variation and stressors. Traditional taxonomy based on morphology will not be replaced – only enhanced and augmented.. Recent global studies such as the Census of Marine Life (CoML), Consortium for the Barcode of Life (CBL), and others have emphasised the need for integrated morphological and molecular approaches to taxonomic analyses. For example, DNA barcodes derived from voucher specimens identified by expert morphological taxonomists can provide ancillary characters for species identification. However, many marine species remain to be discovered and described, and the developmental stages of many species - even common ones – have not yet been matched to adults.

It is apparent from the SGIMT discussions and questionnaire that, while many marine ecologists recognise the power of molecular approaches, they may yet have difficulty accessing the new methods. In contrast, many molecular biologists may be unaware of practical and applied problems and sampling opportunities that collaboration would provide. **ICES should act as communications link and facilitator between the morphological and molecular taxonomic communities and experts, marine ecologists, fisheries biologists, and others. ICES should highlight opportunities, needs, and requirements for scientists, policy makers and funding agencies and programs.**

To this end the SGIMT would work with the ICES web manager and Expert Groups to manage and deliver data, information, and information products related to the science of taxonomy, with a particular focus on promoting the coordination and integration of morphological and molecular taxonomic approaches. This may include news of developments, current issues, meetings, training opportunities, and workshops. The goal would be to provide access and links to knowledge, resources, research initiatives and expertise via the www, email listservs, and in the scientific literature.

## **1 Opening of the meeting**

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The SGIMT worked by correspondence in 2010.

## **2 Agenda**

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Informal discussions were held via email and the ICES SharePoint site to discuss the ToRs and approaches to best meet them:

- a ) Identify resources, current gaps, and important issues in taxonomic research;
- b ) Provide a platform for promotion and exchange of relevant scientific information;
- c ) Initiate and support provision of standards, training materials, and taxonomy workshops;
- d ) Assist in the revision and development of species identification keys;
- e ) Develop the continuing integration of molecular and morphological taxonomy;
- f ) Advise on the implications of developments for marine science and management;
- g ) Provide recommendations on approaches for the effective and broad dissemination of knowledge developed by the expert group, including estimates of resource requirements;
- h ) Consider potential contributions to the high priority topics of ICES Science Plan via the SharePoint site. Consider your current expertise and rank the contributions by High, Low or Medium importance;
- i ) Consider potential contributions for the 2010 SSGEF session during the ASC on the topic areas of the Science Plan which cover: Individual, population and community level growth, feeding and reproduction; the quality of habitats and the threats to them; indicators of ecosystem health.

**Annex 1: List of participants**

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Other Experts who aided in discussion and through responses to the SGIMT Questionnaire			



## Annex 2: SGIMT draft resolution for the meeting in 2012

The **Study Group on Integrated Morphological and Molecular Taxonomy** (SGIMT), chaired by Ann Bucklin\*, USA, will meet by correspondence and in association with the 2012 WGZE meeting in Malaga, Spain, March 2012 [to be announced] to:

- a) Identify resources, current gaps, and important issues in taxonomic research:
  - i. Expand membership of the SG to ensure a balance of expertise between morphological and molecular taxonomic approaches and across taxonomic groups.
  - ii. Develop a web platform for promotion and exchange of relevant scientific information;
  - iii. Initiate and support provision of standards, training materials, and taxonomy workshops;
  - iv. Assist in the revision and development of species identification keys;
  - v. Develop the continuing integration of molecular and morphological taxonomy;
  - vi. Advise on the implications of developments for marine science and management.

SGIMT will report by 15 June 2012 (via SSGEF) for the attention of WGZE and SCI-COM.

### Supporting information

Priority:	The activities of this Group will assist ICES and its Expert Groups with issues related to the development, dissemination and application of taxonomic knowledge and skills. These skills underpin much of the work of ICES and ICES expert marine scientists, and policy demands are driving increased need for taxonomy in ecosystem approaches, affects of fisheries and contaminants, development and application of GES indicators, climate change issues etc. The growing need for taxonomy, with its new developments and methods, with problems of dispersed knowledge, scarce expertise and data quality issues; these make the study group's activities important and high priority.
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Scientific justification and relation to action plan:	Taxonomy is a fundamental discipline in general and evolutionary biology, ecology, and environmental management. As such, this discipline is critical to successful understanding, assessment and management of the species diversity and relationships in both undisturbed ecosystems and those affected by natural or human activities such as climate change, ocean acidification, industrial pressures, and/or eutrophication. There are globally increasing demands on this science. There are also many efforts to reverse the decline in marine taxonomic expertise and to advance traditional morphology-based phylogenies into the new frontiers opened up by molecular genetics. WGZE has sponsored and arranged plankton taxonomic workshops and has strong associations with several of these global initiatives. Taxonomic experts are relatively few in many but not all ICES nations and they tend to specialise in certain taxa rather than generally across the diversity of plankton species.
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ICES' major role is in the collation, archiving, and dissemination of scientific data, analyses and evidence based advice to support policy making, regulatory control. These activities support the conservation and sustainable use of marine resources and ecosystems and ICES facilitates international collaborative science to achieve these aims. ICES has critical supporting and training roles in global

	<p>marine science, through promoting scientific standards, new research and developments and training opportunities. Taxonomic standards and descriptions are subject to constant change and development. Particularly, taxonomy grows with new molecular approaches to species phylogeny, evolution, species adaptive capacities, environmental sensitivities and community diversity. These are highly significant new developments that in a few years will have revolutionised the monitoring and study of marine species and ecosystems. It is essential that ICES adopts a positive supporting role in assessing taxonomic methods, information and potential new techniques by coordinating and promoting developments and information feed-back to the scientific community that supports ICES data provision, analyses, and advice.</p> <p>Considering the plethora of internet and other developments in taxonomic information, ICES should develop its own web-based taxonomic information. Many existing efforts (e.g., CoML/CmarZ, EU MARBEF, EDIT, GBIF, and PESI networks) have limited terms; ICES can assist with coordination to ensure continued development and evolution through such short-term efforts. ICES has a role in conserving and developing the gains these programs have made and ensuring the dissemination of results to ICES scientists and their colleagues. Collectively and individually, these global efforts focused on traditional and molecular taxonomy amount to a valuable and developing resource. ICES as a stable, long lived and international institution has a major role to play in the collation, review, and application of these efforts, in promoting best practices and standards while coordinating development and dissemination of such information.</p>
Resource requirements:	The research programs and Expert Group activities that provide input and are stakeholders for this group are already in place. The additional resources required for SGIMT to pursue the planned activities are: 1) effort by an ICES web manager to help SGIMT create and maintain a web presence with taxonomic information and links; and 2) approval of a planned SGIMT meeting in association with the 2012 WGZE meeting.
Participants:	The Study Group has a limited membership at present, but is expected to grow during 2012 to include scientists from other ICES Expert Groups and other related programs and initiatives with appropriate skills. The goal is to ensure that the membership is balanced across taxonomic groups, ICES geographic regions, and morphological-molecular expertise and knowledge.
Secretariat facilities:	None.
Financial:	No financial implications.
Linkages to advisory committees:	There are no direct linkages with the advisory committees.
Linkages to other committees or groups:	The Study Group arose from the WGZE as a response to a perceived need. This was to promote and support morphological and molecular taxonomy science for the benefit of many ICES Expert Groups and marine science generally.
Linkages to other organizations:	The work of this group relates to and is connected to a diversity of other projects and organisations, e.g., CoML/CMarZ, EU MARBEF, EDIT, GBIF, PESI, GOBI, and others.