

PROGRESS REPORT

<p>1. Project Title: Taxonomy and Ecology of Bethylid Wasps (Chrysidoidea: Bethylidae) from India</p>	<p>File No: SB/YS/LS-42/2014</p>
<p>2. PI (Name & Address): Dr. Santhosh, S. Assistant Professor, Dept. of Zoology, Malabar Christian College, Calicut, Kerala-673 001.</p>	<p>Date of Birth: 01/02/1979</p>
<p>4. Broad area of Research: Life Sciences</p> <p>4.1 Sub Area: Biodiversity and Systematics</p>	
<p>5. Approved Objectives of the Proposal:</p> <p>5.1 To discover and describe the new taxa of bethylid wasps of India</p> <p>5.2 To re-describe the poorly known taxa from the available type materials</p> <p>5.3 To provide workable illustrated dichotomous keys for the identification of the species and genera</p> <p>5.4 To provide computer based interactive keys providing easy and flexible order of characters for identification</p> <p>5.5 To gather information on the habitat and hosts of the bethylid wasps and to prepare a host parasitoid index</p> <p>5.6 To provide updated information on the distribution of these subfamilies in India and to generate distribution maps for the species under study</p> <p>5.7 Preparation of illustrated field book for easy identification of bethylid wasps</p>	
<p>Date of Start: 21/11/2014</p>	<p>Total cost of Project: 25,00,000.00</p>
<p>Date of completion: 20/11/2017</p>	

Salient Research Achievements:

7.1 Summary of Progress

1. Five hundred and sixty three specimens under 20 genera were collected during the period of study from 2014–2016, all of them mounted and identified up to subfamily/genus/species levels.
2. Mounted specimens were registered and tagged with voucher numbers.
3. More than 50 specimens of Mesitiinae were collected during the period.
4. An Afrotropical genus, *Prosapanesia* was discovered for the first time from the Oriental region with two new species and the record is published.
5. A brachypterous *Holepyris* sp., which is found to be the first brachypterous bethylid from the Oriental region is under study.
6. Palearctic monotypic genus, *Alloplastanoxus* is discovered for the first time from the Oriental region.
7. Presence of thick and plate like sensilla placodea (sensory apparatus found in the antennae of insects) in bethylid wasp is confirmed in the antennae of *Prosapanesia* spp. This character is not developed in the bethylid genera having eyes and wings. In the species of female *Prosapanesia*, which lack eyes and wings, this structure is found to substitute the sensory functions of eyes.
8. *Acrepyris*, *Protisobrachium*, *Glenosema*, *Isobrachium*, *Heterocoelia* and *Protisobrachium* are the genera discovered and recorded for the first time from Indian subcontinent.
9. Phoretic copulation of *Dissomphalus* is first of its record from the Oriental region.
10. *Sclerodermus variegatus* Krombein, *Odontepyris meusebecki* Krombein and *Glenosema dispersum* Krombein are the Sri Lankan species reported for the first time from India.
11. Revision of genera *Goniozus*, *Sierola*, *Prosapanesia* and *Formosiepyris* are completed and either published or under progress for publication.
12. Specimens are also procured on loan or specimen exchange MoUs from Gujarat and Rajasthan. Similar MoUs are under progress with ATREE, Bangalore and PIs of ICAR and MoEF funded Network Projects Centres.
13. Eastern distributional range of *Formosiepyris* is extended to Bangladesh with the present study.
14. *Epyris*, *Holepyris* and *Apanesia* are found to be highly speciose and abundant in the Indian sub continent.
15. As per the inputs from seasonal collections from MTs, post monsoon period is found to be highly rewarding period for bethylids.



Figure 1. New species and association. A) *Goniozus inauditus* Santhosh; B) *Goniozus kuriani* Santhosh; C & D) *Goniozus kuriani* Santhosh on leaf gall of *Syzygium cumini*; E) *Prosapanesia emarginata* Santhosh & Ranjith sp. nov.; F) *Prosapanesia orientalia* Ranjith & Santhosh sp. nov.



Figure 2. New species. A) *Sierola narendrani* Santhosh sp. nov.; B) *Sierola nasseri* Santhosh sp. nov.; C) *Formosiepyris* sp. nov. 1; D) *Formosiepyris* sp. nov. 2; E) *Formosiepyris* sp. nov. 3; F) *Alloplastanoxus* sp. nov.



Figure 3. New species, observation and new generic records from India. A & B) Brachypterous *Holepyris* sp. nov.; C) Thick and plate like sensilla placodea in *Prosapanesia emarginata* Santhosh & Ranjith sp. nov.; D) *Acrepyris* sp.; E) *Glenosema dispersum* Krombein; F) *Isobrachium* sp.

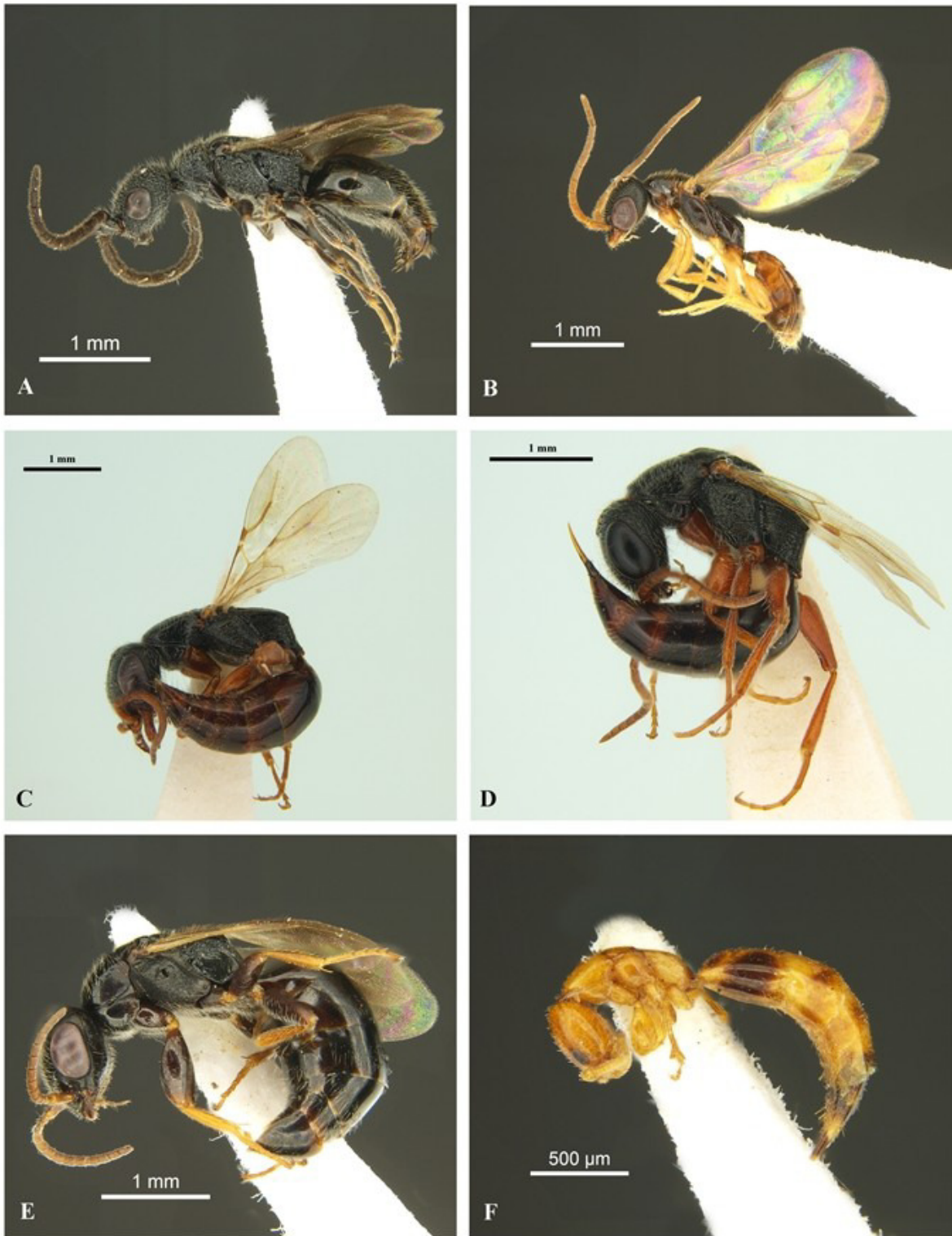


Figure 4. New generic and species records from India. A) *Heteroceleia* sp.; B) *Protisobrachium* sp.; C) *Formosiepyris shiva* Terayama, male; D) *Formosiepyris takasago* Terayama, female; E) *Odontepyrus muesebecki* Krombein; F) *Sclerodermus variegatus* Krombein.



Figure 5. Generic records. A) *Apanesia* sp.; B) *Cephalonomia* sp.; C) *Dissomphalus* sp. male; D) *Dissomphalus* sp. female; E) *Epyris* sp.; F) *Goniozus* sp.

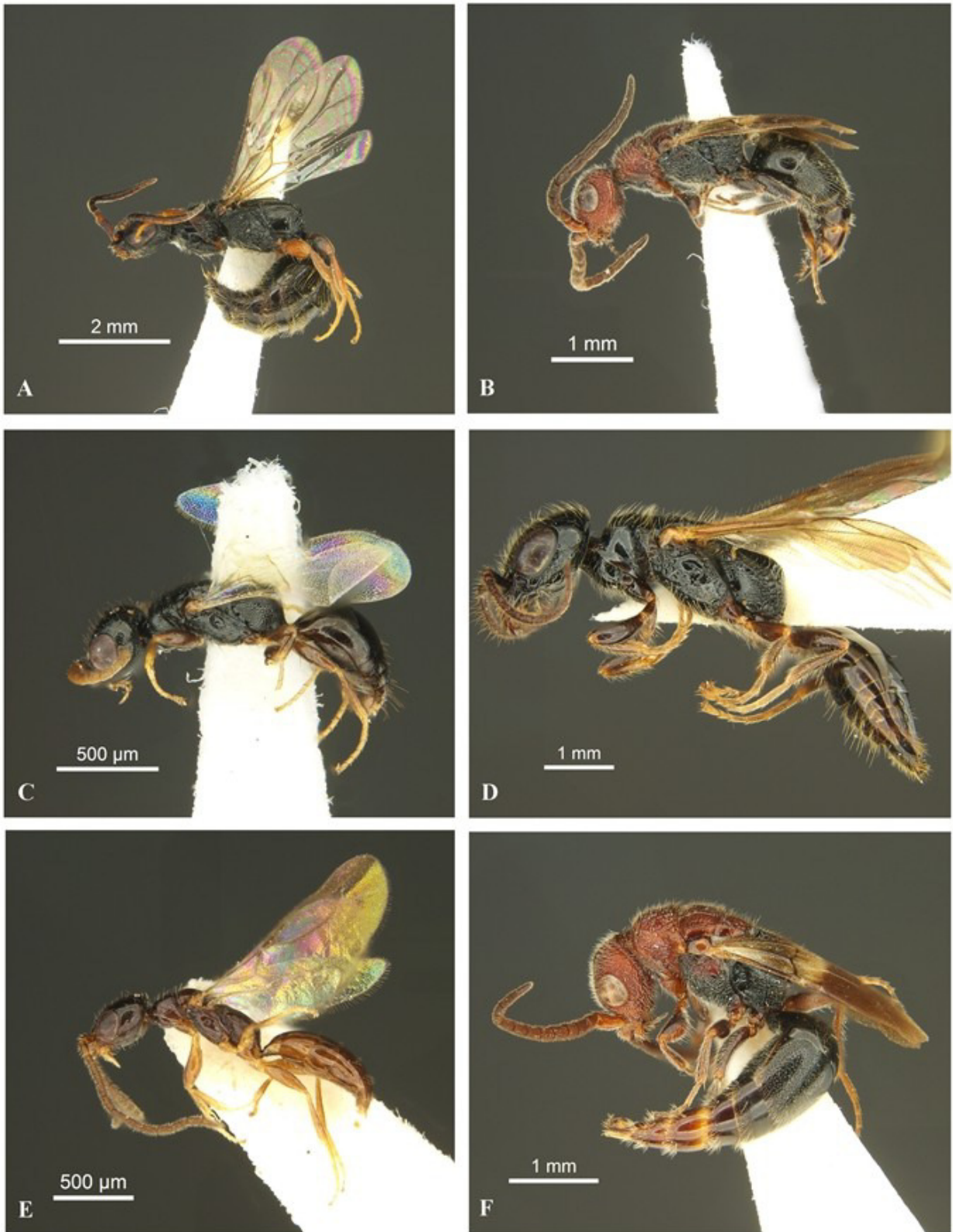


Figure 6. Generic records. A) *Holepyris* sp.; B) *Incertosulcus* sp.; C) *Laelius* sp.; D) *Pristocera* sp.; E) *Rhabdepyris* sp.; F) *Sulcomesitius* sp.

7.2 New Observations:

1. Three new species of *Formosiepyris* were collected and described along with a new distribution record of a Taiwanese species, *F. takasago* Terayama.
2. Male specimen of *Formosiepyris shiva* Terayama and female specimen of *Formosiepyris takasago* Terayama were described for the first time.
3. Eastern boundary of the distributional range of *Formosiepyris* is found to be extended to Bangladesh.
4. *Alloplastanoxus* is recorded for the first time from the Oriental region.
5. Two new species of *Prosapanesia* are collected and this is the first record of this genus from the Oriental region.
6. Phoretic copulation of *Dissomphalus* is observed for the first time from the Oriental region.
7. Three Sri Lankan species are recorded for the first time from India.
8. Three new species of *Protisobrachium* and one new species of *Glenosema* is collected and getting described.
9. Twenty six new species of *Goniozus* are described and a key to Oriental region is developed. Two of them published.
10. Presence of thick and plate like sensilla placodea (sensory apparatus found in the antennae of insects) in bethylid wasps was confirmed. Previously this character is presented in some bethylid species by thin, stub like process.
11. First brachypterous bethylid (*Holepyris* sp.) from the Oriental region was collected. Only two species were already reported as brachypterous *Holepyris* one from Japan (*Holepyris tsugaruensis* Terayama) and one from USA (*Holepyris subapterus* (Melander & Brues)).
12. Three new species viz., *Goniozus inauditus* sp. nov., *Sierola nasseri* sp. nov. and *Goniozus kuriani* sp. nov. were collected from the insect induced leaf galls of *Memcylon umbellatum* Brum. F. and *Syzigium cumini* Linn. respectively.
13. Three host-parasitoid relationships are identified as new to science viz., *Goniozus orthagae* sp. nov. was emerged from the larvae of mango leaf webber, *Orthaga exvinacea* Hampson. *Goniozus platycephalus* sp. nov. was emerged from the larvae of rice leaf folder, *Cnaphalocrocis medinalis* (Guenée). *Goniozus aproaeremae* sp. nov. was emerged from the larvae of ground nut leaf miner, *Aproaeremae modicella* (Deventer).
14. Six new *Goniozus* species namely, *G. antennalis* sp. nov., *G. aproaeremae* sp. nov., *G. mandibularis* sp. nov., *G. nuperus* sp. nov., *G. platycephalus* sp. nov. and *G. recentis* sp. nov. are reported for the first time from rice fields.

7.3 Innovations:

1. Bethylid-plant interaction like the interaction with the gall inducing/inquilines.
2. New host parasitoid relationships for their biocontrol application in the integrated pest management programmes.
3. Emergence pattern of bethylids are under study for possible relationship between life history strategies and seasons.
4. New distributional range extensions of bethylid genera are discovered and the geographical isolation of distantly distributed taxa at present are getting revised.
5. Studies on morphological delimitations like lack of eye, aptery and brachyptery of bethylids in the context of the special structural modifications in such species throw light on their ecological adaptations.

6. Correlation of bethylid abundance to habitat type to derive information useful in the successful use of their biological control potential.
7. Influence of altitudinal variation on the distribution of bethylids are under investigation for information on climate and land use change.

7.4 Application Potential:

7.4.1 Long Term

Biological control: Many of the bethylids are the potential larval parasitoids of agriculturally important pests like *Opisina arenosella* (Walker). The extensive collection and mass culture of this parasitoid help to find the way to control the pest in India as well as abroad.

The present study gives the information about the bethylid parasitoids associated with two serious pests in Kerala as well as other states viz., *Orthaga exvinacea* and *Aproaeremae modicella*.

7.4.2 Immediate

Contribution to Biodiversity Studies: Since very little researches have been done on the Taxonomy of Indian bethylids and no monograph and an updated check list are produced so far, the proposed study about the bethylid fauna of India may give a valued contribution towards the knowledge of its biodiversity.

7.5 Any other:

Publications awaited

1. Paper on "Revision of Oriental *Sierola* Cameron with the description of two new species from Indian sub continent" *In press for T.C. Narendran commemoration volume* (Edited book).
2. Paper of "Revision of *Formosiepyris* Terayama with the description of three new species from India and Bangladesh" is in progress and will be submitted in Aug. 2016
3. Paper on "Revision of Oriental *Sclerodermus* Latreille with the description of two new species from India" is in progress and will be submitted by Oct. 2016.
4. Paper on "First record of the brachyptery in Bethylidae from the Oriental region with the description of one new species" is in progress.
5. Paper on "First record of the Palearctic genus *Alloplastanoxus* from the Oriental region" is in progress.

8. Research work which remains to be done under the project (for on-going projects)

1. Collections from the remaining parts of India will be done. Specimens will be identified and new taxa will be described with illustrations.
2. Re-describe the poorly known taxa from the available type materials on loan from Museums.
3. Preparation of dichotomous keys to remaining genera to be studied.
4. Revision of the Epyrinae and Mesitiinae.
5. Preparation of checklist of bethylids of India.

<ol style="list-style-type: none"> 6. Provide information on the habitat and hosts of the bethylid wasps and prepare host parasitoid index. 7. Provide updates on bethylid distribution in India and generate distribution maps for the species under study. 8. Publication of research papers. 9. Preparation of illustrated field book for easy identification of bethylid wasps 		
Ph.Ds Produced no: 0	Technical Personnel trained: 1	Research Publications arising out of the present project: 3
<p>List of Publications from this Project (including title, author(s), journals & year(s))</p> <p>(A) Papers published only in cited Journals (SCI)</p> <ol style="list-style-type: none"> 6. Santhosh, S. & A.P. Ranjith (2016) Extending Afrotropical endemism: Discovery of <i>Prosapanesia</i> Kieffer (Hymenoptera: Bethyridae) from the Oriental region with the description of two new species. <i>Journal of Asia-Pacific Entomology</i>, 19: 761-767. 7. Santhosh, S. & A.P. Ranjith (2015) Descriptions of two new Species of <i>Goniozus</i> Förster, 1856 (Hymenoptera: Bethyridae) associated with insect induced plant galls from India. <i>Zootaxa</i>, 4039 (1): 192–200. <p>(B) Papers published in Conference Proceedings, Popular Journals, Edited Books etc.</p> <ol style="list-style-type: none"> 1. Santhosh, S. 2015. General Introduction to Insect Classification: Morphology, Terminology, Collecting and Curating. In National level workshop on the Identification of Bees, Wasps, Bugs and Beetles of Southern Western Ghats conducted on 27th–28th February 2015 at Malabar Christian College, Kozhikkode sponsored by University Grants Commission in association with Prof. T.C. Narendran Trust for Animal Taxonomy, Calicut and Zoological Survey of India, Calicut. <p>Patents filed/ to be filed: Nil</p>		

Major Equipment (Model and Make):

Leica M 205A microscope (German Make): Fully automated.

Leica DMC 2900 camera

Automontage Image combination processing system

Desktop Computer (Dell)

Sl No.	Sanctioned List	Procured (Yes/ No) Model & make	Cost Rs (in Lakhs)	Working (Yes/ No)	Utilization Rate (%)
1	Stereozoom trinocular microscope and automontage software (Yes; Leica M205A microscope (Germany)	15,00,000.00	Yes	100