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Abstract: The larvae and adults of 962 African, mostly South African, Lepidoptera species reared by the Caterpillar Rearing Group (CRG) are illustrated together with pertinent host information. This constitutes a substantial rapid growth in the knowledge of the early stages of African Lepidoptera. The majority of these are illustrated for the first time. The methods developed and employed for the establishment and maintenance of the highly successful CRG are described in some detail. The results are summarised and discussed. It is shown that the combination of modern communication and imaging techniques with proper scientific methods and discipline does allow for the rapid expansion of fundamental biological knowledge at low cost.

Key words: Lepidoptera, caterpillar, larva, moth, butterfly, South Africa, Africa, Afrotropical region, pupa, host, life-history.


INTRODUCTION

The Caterpillar Rearing Group (CRG) is a project of the Lepidopterists’ Society of Africa (LepSoc). It combines the efforts of lepidopterists and other naturalists throughout the region to record the early stages of Afrotropical Lepidoptera and identify them, their hosts and their parasitoids. This project is especially important for discovering previously unknown Lepidoptera life-histories and will contribute significantly to the conservation of this group of insects on the African continent, because it almost impossible to conserve a threatened species if its life-history is unknown (Edge, 2011; Edge & Mecenero, 2015; Mecenero, Edge & Staude, 2015; Terblanche & van Hamburg, 2004). The scope and goals of the CRG project are outlined in an overview document (Mecenero et al., 2014).

The idea of creating a single catalogue for recording rearing records conducted on African Lepidoptera is not new. Lamenting the fact that so many rearing records are never published and as a result are lost to science, Staude & Joannou (1993) appealed to fellow lepidopterists to inform them of such rearing records so as to enable them to produce collective, annual lists of rearing records. The response to the call was poor, and as a result such lists were never produced. Staude (2008) later published a list of 118 rearing records of Geometridae, including host-plant associations and other annotations. Already then about 20 % of these contributions were from contributors other than the author. This list was later expanded to include photographs of the caterpillars (larvae) and adults and formed the core of the current master lists of the CRG.

In September 2012, Staude & Kroon (2012) issued a challenge to other lepidopterists and nature enthusiasts to rear, photograph and record more larva-host-adult associations of South African moths during the 2012/2013 season than these two authors could. The
challenge was called The Great Moth Caterpillar-hunt Challenge (TGMCC). Handsome prizes were offered and a media campaign was launched to promote the challenge. The response exceeded expectations. Twenty-eight participants submitted 814 rearing records comprising 548 species (including of rearings conducted before 2012), and the early stages of 82 species and 185 host-associations were recorded for the first time. Staude (2014) compiled a comprehensive summary of these results. At the TGMCC prize-giving event in Magaliesburg on 16 November 2013, it was decided to continue this effort. The project was formally named the Caterpillar Rearing Group (CRG) and expanded to include all Afrotropical Lepidoptera, although efforts to date have been concentrated on the fauna of southern Africa.

The main focus and activity of the CRG is the compilation of lists of rearing records on African Lepidoptera, containing baseline information on dates, localities, larval hosts, photographs of larvae, adults and parasitoids and references to pertinent literature or other resources providing further details of the rearing. In this article we present the novel method that forms the core of the project, the master lists compiled from all rearing records submitted up to 31 December 2015, and an analysis of the results to date.

**History of caterpillar rearing in South Africa**

The early stages of Lepidoptera have fascinated mankind for centuries, but it was only during the eighteenth century in Europe that people started recording Lepidoptera life-histories in earnest. One of the first major works containing detailed illustrations of Lepidoptera life-histories was the well-known *Metamorphosis Insectorum Surinamensium* by Maria Sibylla Merian, published in 1705. Other good examples of the quality of 18th-century work are the excellent full-colour paintings of the life cycles of moths and butterflies made by the father-and-son team Sepp, which appeared as subscription plates in the Netherlands from 1762. Many of these plates were re-published by McNeill (1978).

In the South African context, Roland Trimen (1862, 1887–1889) illustrated a few caterpillars in his publications, but it is Lieut.-Colonel James Farish Malcolm Fawcett who can be described as the father of caterpillar rearing in South Africa. He reared and painted an inordinate number of butterfly and moth larvae during his short time in South Africa, during brief periods of “leisure” when his regiment was not on the march. He published two important articles from this work (Fawcett, 1901; 1903), containing short notes and seven magnificent colour plates of the larvae, host-plants and some adults of various Lepidoptera occurring mainly in the former Natal province (the vicinity of Durban) but a few also from Belfast in the former Transvaal province. Several of the rearing records and paintings were contributed by his fellow lepidopterists and friends J. F. Quekett, W. Haygarth and A. D. Millar, residing in Durban at the time.

It is possible that this pioneering work inspired Ernest Platt, who befriended the same circle of caterpillar rearers in Durban, to dedicate more than 20 years of his studies on Lepidoptera to their early stages. His work culminated in an extensive list of Lepidoptera host-plants (Platt, 1921). He also built up a large collection of dried larvae, pupae and reared adults and kept handwritten notes on his rearings. The notes and many adults are housed in the Albany Museum in Grahamstown and the larvae in the Ditsong Museum of Natural History (DMNH) in Pretoria (Kroon, 1999). Like Fawcett, Platt had a circle of fellow Lepidoptera rearers around him, notably H. W. Bell-Marley, L. Clark and G. F. Leigh, whose expertly blown larvae are also preserved in the DMNH, indicating that caterpillar rearing was practised rather widely in Natal during the first quarter of the twentieth century.

Margaret E. Fountaine visited South Africa for two years (1908–1909) and travelled widely during this time, mainly in Natal, rearing and painting the early stages of butterflies, and she also befriended A. D. Millar and G. F. Leigh in Durban. Most of her work remains unpublished, but she did publish a paper describing and illustrating partial life-histories of some South African butterflies (Fountaine, 1911).

Gowan C. Clark, from Port Elizabeth, inspired by the beautiful colour plates of life-histories of British butterflies published by Frohawk (1914, 1921), illustrated the life-histories of many South African Lepidoptera (Ball, 1994). He produced 340 full-colour plates, each depicting the life-history of a different species as a series of detailed paintings of eggs, different larval instars, pupae, adults and hostplants (Ball, 1996). Three-hundred-and-twenty of these plates illustrate the life stages of butterflies, most prepared from larvae reared from eggs, obtained by following females and observing them ovipositing on host-plants in the field (Clark & Dickson, 1971). In the 1930s Clark joined forces with Charles G. C. Dickson, who continuously supplied him with further material to illustrate (Henning, 1992), and together they published many short papers (Clark & Dickson, 1956a–b; 1957a–d; 1960; 1963; 1964). After Clark’s death in 1964, Dickson published the Lycaenidae part of their work (Clark & Dickson, 1971). The rest of Clark’s unsurpassed plates were also published but spread over a number of works, mostly not authored by him (Clark, 1951; Van Son, 1949–1979; Van den Berg, 1975a; Dickson & Kroon, 1978; Pringle et al., 1994).

Dickson became interested in butterflies at an early age, partly influenced by his family’s friendship with Trimen (Henning, 1992). Apart from his many other accomplishments, he spent a lot of time in the field and in the laboratory working on the life-histories of South African butterflies, which resulted in a number of papers on their early stages in addition to those he produced in partnership with Clark (Dickson, 1940; 1943; 1944a–b; 1945a–b; 1947a–b; 1948; 1949; 1952; 1953; 1959; 1991).
J. Sneyd Taylor, working for the former Division of Entomology in Port Elizabeth and also a friend of Clark’s and Dickson’s, reared many Lepidoptera species, mostly moths, from field-collected larvae in the Eastern Cape Province during the period 1940–1965. He did not illustrate the early stages (apart from a single photograph of a *Bunaea alcinoe* caterpillar) but described the caterpillars, their life-histories and host-associations in some detail. His main work was a five-part series entitled ‘Notes on Lepidoptera in the Eastern Cape Province’ (Taylor, 1949–1965). He also produced an extensive list of tachinid flies he had found parasitizing the Lepidoptera larvae he reared (Taylor, 1961).

Other government entomologists undertook comprehensive studies on the life-histories of Lepidoptera species considered as forestry pests, providing detailed descriptions and sometimes also colour plates depicting all developmental stages (Tooke & Hubbard, 1941; Grobler, 1957; Hepburn & Loedolf, 1964; Hepburn et al., 1966; Geertsema, 1971, 1975; Geertsema & Gilioomee, 1972; van den Berg, 1974a–c, 1975a–b). The life-histories of other agriculturally important Lepidoptera species are summarised by Prinsloo & Uys (2015).

Andre Claassens, also a friend of Dickson’s, experimented with ways of working out the life-histories of the difficult-to-rear myrmecophilous Lycaenidae (Claassens 1974, 1976). He continued to rear butterflies and some moths ever since, and some of his rearing records are here included.

Another prolific breeder of Lepidoptera was Arthur Duke, who befriended Dickson whilst living in Cape Town, and subsequently for many years he and his son, Neville Duke, collected and reared hundreds of southern African moths, mainly in the Eastern Cape Province, Harare and other parts of Zimbabwe and later (Neville) in Swaziland. Neville Duke was in the process of compiling a comprehensive list of the host-associations accumulated by this formidable father-and-son team, and he intended to publish this list as well as a book on sphingid life-histories, but his untimely death in 1998 curtailed both these projects. The Geometridae part of this list was published posthumously (Duke & Duke, 1998). The rest of the list, together with rearing notes, photographs of larvae and reared adult moths, is housed in the DMNH.

The host-plant information contained in the Dukes’ unpublished list was transcribed to a database by Douglas Kroon, who also meticulously sieved through all available published and unpublished literature containing Lepidoptera host-associations and added these records to his database, as well as host-associations obtained from his own rearings. From this database he produced a comprehensive catalogue of host-associations for southern African Lepidoptera (Kroon, 1999). This seminal book is still used today by the CRG as a basis for determining known host-associations.

In the early 1980s, caterpillar rearing was practised widely by members of the then newly formed Lepidopterists’ Society of Southern Africa (Braine & Henning, 1984; Williams, 1985; 1986). The Dukes, Kroon, Rolf Oberprieler and Mark Williams reared mainly moths, and many of the rearings recorded in this publication emanate from these activities. John Joannou, Rob Pare, Graham Henning, Stephen Henning and Steve Woodhall reared mostly butterflies, culminating in a book series (Henning et al., 1997) that has, unfortunately, remained incomplete.


A first concerted effort of promoting the rearing, recording and study of Lepidoptera larvae and life-histories among members of LepSoc was a workshop held on the 10 June 1995 in Pretoria, convened by Mark Williams. Williams (1996b) published an account of this workshop, describing caterpillar rearing methods and the state of knowledge on the life-histories of southern African butterflies at the time. Despite these efforts, however, caterpillar rearing and the recording of Lepidoptera life-histories remained a rather haphazard affair in the LepSoc, driven by individual predilections and not covering a wide
spectrum of the diversity of the southern African Lepidoptera fauna.

The rearing efforts of more than a century notwithstanding, Staude & Kroon (2012) estimated that the early stages of more than 90% of the South African Lepidoptera fauna remained unknown. In an attempt to alleviate this situation, the advent of the CRG in 2012, as reported in this paper, shifted the focus of caterpillar rearing significantly from individual preferences back to a more general moth and butterfly rearing effort, more like Fawcett and Platt and their fellow rearers had done earlier, but in a much more concerted manner.

**MATERIALS AND METHODS**

**Terminology**

The terms ‘caterpillar’ and ‘larva’ are used interchangeably in this article, although they are not fully synonymous. ‘Larva’ (plural: larvae) is the technical term for the life stage of any holometabolous insect between egg and pupa, whereas ‘caterpillar’ is a vernacular term for the (generally free-living) larvae of moths and butterflies (Lepidoptera) as well as those of sawflies (Hymenoptera). The rearing efforts of the CRG do not cover the caterpillars of sawflies, however.

**Approach and protocol**

Members of the public at large were and still are invited to rear the larvae of all African Lepidoptera and keep records of the rearings. They are encouraged and guided to rear to adulthood any life stage of moth or butterfly they come across, to photograph all life stages and hosts, to record all observations, to preserve voucher specimens of the reared moth or butterfly as well as of the host-plants and any parasitoids and to submit the records and vouchers to the CRG management. At minimum the following information is required with each submission, generally by e-mail to the CRG management: locality description including longitude and latitude, name of host-plant if available, date of collection of life stage, date of pupation, date of emergence of adult, photographs of caterpillar, pupa, adult, host and parasitoid. All photographs and data submitted by participants are electronically stored by the CRG management under the names of the individual contributors. At the time of writing, over 35 000 images and documents have been received.

**Creating a challenging and competitive environment**

The project was launched in September 2012 by way of a challenge that people could relate to (Staude & Kroon, 2012). Named the TGMCC, it ran until October 2013. The idea was novel enough to attract the attention of the media and led to a number of electronic media running with the story (e.g. Highlands Wilderness, 2012; Staude & Kroon, 2012; iSpot, 2013). Radio interviews were also held (see www.youtube.com/watch?v=B_M3hE8Mwqk and www.facebook.com/groups/caterpillarrg/files/).

Due to the success of the TGMCC, the project was continued as the CRG, launched in November 2013. A number of challenges and sub-Challenges were advertised (Mecenero et al., 2014; Mecenero & Sharp, 2014a). For the current 2015/2016 season similar challenges are in place.

Various prizes were awarded and are on offer for winners. Prizes have ranged from a substantial annual monetary amount for the overall winner who scores the most points (based on the adopted scoring system) to a number of smaller ones, comprising books and equipment for the winners of specific sub-challenges (e.g. rearing the most micro-moths in a given time period).

**Training of participants**

In order to assist and guide fellow lepidopterists and members of the public to participate in the project, some documents were produced, containing information on how to find and rear caterpillars, how to record and file rearing data and how to submit records to the project (Sharp & Mecenero, 2014b,c,d; Parry, 2015). These documents are freely accessible on the CRG Facebook page (see below) as well as on the LepSoc website (www.lepsoc.org.za).

**Scoring system for submitted rearing records**

A scoring system was developed to assess the scientific value of each rearing (Table 1). A rearing becomes eligible if, at the very least, photographs of the larva and the resultant moth or butterfly or parasitoid are submitted, but its score is increased if it presents data that are new to the CRG or new to science. This scoring system was developed in such a way that relevant statistical data can be readily extracted from the master lists that collate all the submitted rearing records (see results section).

<table>
<thead>
<tr>
<th>Result of rearing</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recording a new full life-history of a species</td>
<td>20</td>
</tr>
<tr>
<td>Recording a new partial life-history of a species</td>
<td>10</td>
</tr>
<tr>
<td>Recording a partial life-history of a species new to the CRG and new host</td>
<td>8</td>
</tr>
<tr>
<td>Recording a partial life-history of a species new to the CRG</td>
<td>5</td>
</tr>
<tr>
<td>Recording a new host</td>
<td>3</td>
</tr>
<tr>
<td>Recording a new rearing locality for the species</td>
<td>2</td>
</tr>
<tr>
<td>Recording a repeat experiment</td>
<td>1</td>
</tr>
</tbody>
</table>

**Table 1 – Scoring system used by the CRG project to evaluate rearing records submitted to the CRG management. ‘New’ designates a life-history not recorded in the published literature prior to the rearing, ‘New to the CRG’ designates an association not recorded before in the CRG master lists.**
Recognising achievements

A formal system was devised to recognise the achievements of individual contributors and to suit all participants, from beginner to expert (Table 2). Certificates of achievement are presented to contributors reaching specific targets at CRG meetings or LepSoc conferences. CRG participants are encouraged to set specific targets for themselves regarding the number of species they successfully rear from larva to adult and the rearing records they submit. The highest levels of achievement have not been reached yet (Table 2), and these constitute goals that, when achieved, will be significant enough to deserve wide recognition by peers.

Table 2 – Caterpillar rearer achievement levels

<table>
<thead>
<tr>
<th>Target - species reared/ records submitted</th>
<th>Caterpillar rearer achievement level</th>
<th>No. of contributors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 species</td>
<td>Platinum expert</td>
<td>0</td>
</tr>
<tr>
<td>500 species</td>
<td>Gold expert</td>
<td>0</td>
</tr>
<tr>
<td>250 species</td>
<td>Silver expert</td>
<td>2</td>
</tr>
<tr>
<td>100 species</td>
<td>Expert</td>
<td>2</td>
</tr>
<tr>
<td>50 species</td>
<td>Established</td>
<td>0</td>
</tr>
<tr>
<td>20 species</td>
<td>Green</td>
<td>5</td>
</tr>
<tr>
<td>10 species</td>
<td>Yellow</td>
<td>9</td>
</tr>
<tr>
<td>1 species</td>
<td>Beginner</td>
<td>51</td>
</tr>
</tbody>
</table>

Collating the rearing records into master lists

The main current output of the CRG are the master lists of rearing records conducted on African Lepidoptera.

Initially all rearing records received from participants in the project were entered into a single table and ordered by name of Lepidoptera family, subfamily and species. Host name and family, date of rearing and emergence and thumbnail photographs of larva and corresponding adult were also included. Often the records submitted were incomplete, mostly missing identifications of the Lepidoptera at some or all taxonomic levels and sometimes also of the hosts. Such omissions were rectified during entry to the lowest feasible taxonomic level by members of the CRG management as follows: Bombycoidea – R. Oberprieler; Geometroidea – H. Staude; Papilionoidea – M. Williams; other Lepidoptera – H. Staude (using Staude et al. (2015) as identification tool); host-plants – M. Maclean; parasitoids – N. Parry. In addition, these identifications were vetted by taxon specialists wherever they could be found and were willing to assist. Identifications made or corrected by a taxon specialist are indicated in the master lists after the taxon name.

In the following years, as more and more rearing records were submitted, it became cumbersome and impractical to continue with a single master list, and several lists were created for the major taxonomic groups, at first largely for superfamilies but these now divided into major families and subfamilies. Currently the CRG operates 24 master lists, i.e. Bombycoidea: Bombyciidae & Eupterotidae; Bombycoidea: Lasiocampidae; Bombycoidea: Saturniidae; Bombycoidea: Sphingidae; Gelechioidea; Geometroidea: Uraliidae & Geometridae; Desmophasdrinae & Larentiinae; Geometroidea: Geometridae: Ennominae; Geometroidea: Geometridae: Geometrinae; Geometroidea: Geometridae: Sterrhinae; Noctuoidea: Erebidae: Arctiinae; Noctuoidea: Erebidae: Erebinae; Noctuoidea: Erebidae: Lymantriinae; Noctuoidea: Erebidae: Heliothinae & Noctuinae; Noctuoidea: Noctuidae: Erebidae: Amphipyrinae & Hadeninae; Noctuoidea: Noctuidae: Heliothinae & Noctuinae; Noctuoidea: Noctuidae: Notodontinae; Noctuoidea: others; Papilionoidea & Hesperioidae: Pyraloidea: Crambidae; Pyraloidea: Pyralidae; Tortricidae; and others. New rearing records are continually added to these master lists as they are submitted.

The classification of the Lepidoptera largely follows Van Nieukerken et al. (2011) and the unpublished checklist in the DMNH as kept and updated by M. Krüger. An exception is the family Lasiocampidae, which is included in Bombycoidea (a monotypic superfamily Lasiocampaidea being a redundant taxon). The family classification of the host-plants largely follows the APG II system (APG 2003), which, although superseded by APG III (APG 2009), is used by the South African National Herbarium (of the South African National Biodiversity Institute) in its Botanical Research and Herbarium Management System (BRAHMS) (http://197.189.235.148/).

The localities recorded in the master lists refer to the place of collection of the specimen from which the rearing commenced, be it an early stage (usually egg or larva) or an adult female that laid eggs. Full details of the localities are given in the gazetteer in the supplementary material, including the coordinates (latitude and longitude in degrees, minutes and seconds).

Rearing data previously published, even if only the photograph of a larva or the host record, are referenced, the publications cited in the lists and their references provided at the end of each list.

The main purpose of the master lists is to create a vehicle by which this large and growing set of life-history data can become accessible to other users, from scientists to conservationists to naturalists and everyone else interested in them. The full master lists have become too large to be included in the printed version of this paper, but abridged versions are published as an electronic supplement to this paper, which can be downloaded from the Metamorphosis website. Plans are underway to publish a more Comprehensive account of the life-histories in book form in due course.

Creating a sense of belonging and interacting on social media
A CRG badge is posted to all participants on submission of their first rearing record, together with a covering letter welcoming them to the CRG and emphasizing the value of their contributions. Regular participants are given access to the master lists in a shared Dropbox folder, so as to inform them about the species that have already been recorded and from which host-plants, and to encourage them to target species that have not yet been reared. The master lists are updated on a regular basis so as to make new records available to all rearers as soon as possible.

A CRG Facebook page was created in 2014 (www.facebook.com/groups/caterpillarrg), with the aim of providing a common platform for everyone interested in the immature stages and life-histories of African Lepidoptera and enabling the sharing of records, questions and rearing experiences with like-minded people. This page has proved to be very popular, with posts made almost on a daily basis and over 1000 members at the time of writing. It encourages participants as well as viewers on a regular basis to submit the records of any rearing to the CRG management team. Any reader who wishes to get involved in the CRG can visit the above Facebook page, where all the information is available.

Storage of submitted material

CRG members are encouraged to preserve and submit voucher specimens of reared adults, hosts and parasitoids. Adult specimens, when received, are set and labelled in the standard way for Lepidoptera (Richardson, 2015) and initially stored in the Staude Collection, Magaliesburg. Subsequently the specimens are, where possible, donated to taxon specialists for confirmation of species identifications in the master lists. Pupal cases, parasitoids and some pressed plant specimens are also kept in the Staude Collection until a more suitable depository for them can be found.

Ownership of data and images

A fundamental principle of the CRG in regard to photographs, rearing data and specimens (material) submitted by participating members is that all rights regarding ownership and copyright of the submitted material remain with the originator of such material (member).

By submitting material to the CRG, members grant permission to the CRG management to use their material to create and disseminate documentation for the purposes of promoting the activities of the CRG, specifically the master lists and social media pages. The CRG management will not provide such material to third parties without explicit written permission from the members who submitted such material (the copyright owners). As the principal objective of the CRG is to accumulate and subsequently disseminate information about the African Lepidoptera fauna, the CRG management recommends that members allow third parties to make use of their material if requested, subject to the following minimum conditions:

- Permission to reproduce the provided material is granted on a ‘once off’ basis only, for the purposes as per written request. Ownership and copyright of the material remains with the originator of the material and no transfer or sharing of such ownership or copyright is hereby granted, direct, implied or otherwise.
- The use of such material must be acknowledged at source. In the case of an image the name of the originator must appear clearly visible on or surrounding the image (e.g., photo: S Mecenero). In the case of information, the name of the originator must appear in brackets after the information provided (e.g., A. & I. Sharp, pers. comm.).
- The CRG and its parent organisation, the Lepidopterists’ Society of Africa (Lepsoc), must be acknowledged in the publication as the facilitator of the material and it is recommended that their work be promoted in the publication wherever appropriate.

Encouraging CRG participants to get their results published and CRG-related publications

The master lists contain only rudimentary information on the completed rearings, limited to basic data on localities, dates and hosts. Of course, a successful rearing yields a wealth of additional information, such as the time spent in different larval instars, host-plant preferences, feeding, pupation and emergence behaviour, effects of rearing conditions on larval growth and survival, and much more. CRG members are encouraged to record such observations and submit such notes to the CRG management for safekeeping. In addition they are encouraged to write up these records for publication and submit a manuscript to the Editor of Metamorphosis, either for a scientific note or a full article, depending on the amount of information gathered. The Editor has made a special effort to guide members unfamiliar with scientific writing through the process of preparing an article for publication. Some articles have already appeared due to this process (Sharp & Sharp, 2013; 2014; Maclean, 2015; Sharp, 2015).

The CRG encourages the wealth of unpublished information and photographs it has in storage to be used in related publications. It has already contributed life-history photographs and information to two recent publications (Schintlmeister & Witt, 2015; Woodhall & Gray, 2015). It is the intention of the CRG to produce publications on South African Lepidoptera caterpillars, using CRG information, similar to books that have been produced recently in other regions of the world, such as those of Hausmann & Miller (2000), Wagner (2005), Porter (2010) and Wagner et al. (2011).
Ongoing marketing of the project

The CRG markets itself by various means. Presentations discussing the aims and merits of the project, together with available results, are made at the annual LepSoc conferences in South Africa as well as at other scientific conferences in the country and elsewhere. Newsletters have been, and continue to be, produced and distributed via electronic media, articles published in magazines, regional talks given to interested nature groups whenever opportunities arise and youth days held to take children into the field and show them how to find and rear caterpillars. As the CRG grows, it is hoped that these efforts will also increase and expand.

RESULTS AND DISCUSSION

The following results are based on valid rearing records of Lepidoptera received from CRG participants and recorded in the master lists up to 31 December 2015. The vast majority of submitted records were from South Africa, but we are continuing to encourage submissions from all parts of Africa. Rearing records of parasitoids are not included, as master lists for them were not compiled from the beginning of the CRG project and are currently not comprehensive enough to warrant inclusion here. They will, however, be included in future CRG publications.

At the end of 2015, a total of 38 043 images and text files containing information on African Lepidoptera life-histories had been submitted to the CRG management by participants for storage and safekeeping. The master lists in the supplementary files containing information on African Lepidoptera life-histories had been submitted to the CRG and are currently not comprehensive enough to warrant inclusion here. They will, however, be included in future CRG publications.

The numbers of rearing records received and species reared for the seven taxonomic groups are fairly even except for butterflies (42 and 30). Their low numbers are partly due to the fact that butterflies were excluded in the first year of the project (the TGMCC initiative), resulting in an emphasis on moths in subsequent years, and another likely factor is that participants focussed on rearing new life-histories and therefore avoided rearing already well known butterflies. The percentages of species per rearing are also similar in the seven groups, and all close to the 54.1 % average, except again for butterflies, for which the percentage is significantly higher (71.4%). This again probably reflects an effort to target less well known species in this group.

Starker differences are apparent in the numbers of species reared for the first time and in their percentages of rearings. The low values particularly for butterflies (2 and 4.8 %) but also for Bombycoidea (32 and 9.8 %) reflect the fact that the caterpillars of these two groups of mostly large and showy species are considerably better known than those of other groups, in no small part because they have been targeted in this regard in the past, as outlined under the heading ‘History of Caterpillar Rearing in South Africa’ above. In contrast, the similarly low numbers in Pyraloidea (27 and 15.1 %) and ‘Other Lepidoptera’ (21 and 9.9 %) are largely an artefact of the difficulty of identifying moths to species level in these groups and thus also to ascertain whether they have been reared before. Ongoing efforts to identify the reared specimens in these groups are expected to raise these values, and thus those of Lepidoptera as a whole. The relatively high percentage of first-time rearings in Geometroidea (32.7%), on the other hand, is largely due to the focus of the first author on this group, as 76 (69.1 %) of all new rearings of Geometridae were from this source (Staude 1994a, 1994b, 1997, 1999, 2001, 2008, Staude et al., 2011, Staude & Siivonen, 2014).

A total of 1 389 caterpillar host-associations were recorded, of which 867 (62.4 %) are deemed to be new (Table 4). The percentages of host-association additions per rearing are remarkably similar and high across the seven taxonomic groups (average78.1%). The percentages of new host-associations, however, differ widely between the groups but follow the same pattern as observed in the comparison of species reared in Table 3. The apparent reasons for this variation given for the species above are probably also applicable to the host-associations.

Table 3 – Number of Lepidoptera rearing records received by the CRG to the end of 2015; divided into seven taxonomic groups. The number of species reared and the number of “new” species deemed to be reared for the first time (% of total number of rearing records in parentheses) are provided for each group.

<table>
<thead>
<tr>
<th>Lepidoptera group</th>
<th>Rearing records</th>
<th>Species reared</th>
<th>New species reared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bombycoidea (including Lasiocampidae)</td>
<td>325</td>
<td>148 (45.5)</td>
<td>32 (9.8)</td>
</tr>
<tr>
<td>Geometroidea</td>
<td>336</td>
<td>196 (58.3)</td>
<td>110 (32.7)</td>
</tr>
<tr>
<td>Erebidae</td>
<td>299</td>
<td>136 (45.5)</td>
<td>48 (16.0)</td>
</tr>
<tr>
<td>Noctuoidea other than Erebidae</td>
<td>287</td>
<td>148 (51.6)</td>
<td>52 (18.1)</td>
</tr>
<tr>
<td>Pyraloidea</td>
<td>179</td>
<td>103 (57.5)</td>
<td>27 (15.1)</td>
</tr>
<tr>
<td>Papilionoidea and Hesperioidea</td>
<td>42</td>
<td>30 (71.4)</td>
<td>2 (4.8)</td>
</tr>
<tr>
<td>Other Lepidoptera</td>
<td>310</td>
<td>201 (65.6)</td>
<td>21 (9.9)</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>1778</strong></td>
<td><strong>962 (54.1)</strong></td>
<td><strong>292 (16.4)</strong></td>
</tr>
</tbody>
</table>

Table 4 (next page) – Number of larval host-association records received by the CRG to the end of 2015, divided into seven taxonomic groups. The total number of host-associations and of “new” host-associations deemed to be recorded for the first time (% of total number of rearing records in parentheses) are provided for each group.
Lepidoptera group | Rearing records | Host-associations | New host-associations |
---|---|---|---|
Bombycoidea (including Lasiocampidae) | 325 | 243 (74.8) | 143 (44.0) |
Geometroidea | 336 | 253 (75.3) | 200 (59.5) |
Erebidae | 299 | 230 (76.9) | 182 (60.9) |
Noctuidae other than Erebidae | 287 | 220 (76.7) | 158 (55.0) |
Pyraloidea | 179 | 140 (78.2) | 74 (41.3) |
Papilionoidea and Hesperioidea | 42 | 32 (76.2) | 6 (14.3) |
Other Lepidoptera | 310 | 271 (87.4) | 104 (33.5) |
TOTALS | 1778 | 1389 (78.1) | 867 (48.8) |

The number of rearing records submitted to the CRG over its first five years (seasons) are fairly similar per season (Table 5), with the exception of the 2015-2016 half-season, which will fall significantly short even as a full season if a similar number of submissions as in its first half (90) is received in its second. This is probably due to a number of factors. Some rearers have indicated that they are behind in submitting their data, and the serious drought gripping southern Africa in this season has certainly curtailed the efforts of at least the two most productive contributors. Also, as more and more of the commoner species are being reared, the difficulty and effort of finding and rearing rarer or more localised species increases. This last factor is also detectable in the steady decline in the percentages of newly reared species and new host-associations, both to science and to the CRG, and well in line with expectations.

Table 5 – Comparison of the five seasons (1st July to 30th June) covered by the CRG project to date (2015/2016 only half a season, 1st July to 31st December 2015), with percentages of total number of rearing records in parentheses.

<table>
<thead>
<tr>
<th>Season</th>
<th>Rearing records</th>
<th>Species reared</th>
<th>Host-associations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-07/2012</td>
<td>367</td>
<td>260 (70.8)</td>
<td>323 (88.0)</td>
</tr>
<tr>
<td>2012/13</td>
<td>460</td>
<td>287 (62.4)</td>
<td>379 (82.4)</td>
</tr>
<tr>
<td>2013/14</td>
<td>505</td>
<td>250 (49.5)</td>
<td>374 (74.1)</td>
</tr>
<tr>
<td>2014/15</td>
<td>356</td>
<td>129 (36.2)</td>
<td>252 (70.8)</td>
</tr>
<tr>
<td>2015/16</td>
<td>90</td>
<td>36 (40.0)</td>
<td>61 (67.8)</td>
</tr>
</tbody>
</table>

Sixty-nine participants (as individuals or two-person teams) submitted all the rearing records contained in this report. The contributions of the top 18 participants, as well as the combined contributions of the other 51 participants, are summarised in Table 6. The top four of the 69 participants (5.8 %) submitted 76.6 % of the rearing records. This is in line with expectations for such a public volunteer project. Fifty-one participants submitted fewer than ten rearing records each but together submitted 134 records, demonstrating the cumulative effect of many smaller contributions. The number of additional species per rearing shows a marked decrease as the number of rearings increases (the top four participants, with the highest number of rearings, have the lowest percentages of species reared), but the value of repeat rearings of a species should not be underestimated as host ranges or host specificities become evident only when species are reared repeatedly from larvae found on different hosts and at different localities.

Table 6 – Number of rearing records and species reared as submitted by CRG participants, with percentages of species per number of personal rearing records in parentheses.

<table>
<thead>
<tr>
<th>CRG participants</th>
<th>No. of rearing records</th>
<th>No. of species reared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharp &amp; Sharp</td>
<td>671</td>
<td>394 (58.7)</td>
</tr>
<tr>
<td>Staude</td>
<td>379</td>
<td>278 (73.4)</td>
</tr>
<tr>
<td>Oberprieler</td>
<td>156</td>
<td>124 (79.5)</td>
</tr>
<tr>
<td>Mecenero</td>
<td>191</td>
<td>112 (71.8)</td>
</tr>
<tr>
<td>Morton &amp; Morton</td>
<td>38</td>
<td>37 (97.4)</td>
</tr>
<tr>
<td>Maclean</td>
<td>33</td>
<td>32 (97.0)</td>
</tr>
<tr>
<td>Webb</td>
<td>36</td>
<td>30 (83.3)</td>
</tr>
<tr>
<td>Vermaak</td>
<td>26</td>
<td>22 (84.6)</td>
</tr>
<tr>
<td>Woodhall</td>
<td>21</td>
<td>21 (100)</td>
</tr>
<tr>
<td>Aiston</td>
<td>18</td>
<td>18 (100)</td>
</tr>
<tr>
<td>Schutte</td>
<td>16</td>
<td>16 (100)</td>
</tr>
<tr>
<td>Bode &amp; Bode</td>
<td>16</td>
<td>16 (100)</td>
</tr>
<tr>
<td>Coetzee &amp; Parry</td>
<td>15</td>
<td>15 (100)</td>
</tr>
<tr>
<td>Saksida</td>
<td>13</td>
<td>13 (100)</td>
</tr>
<tr>
<td>Collins</td>
<td>14</td>
<td>13 (92.9)</td>
</tr>
<tr>
<td>Brink</td>
<td>13</td>
<td>13 (100)</td>
</tr>
<tr>
<td>Stadie</td>
<td>13</td>
<td>12 (92.3)</td>
</tr>
<tr>
<td>Joannou†</td>
<td>10</td>
<td>10 (100)</td>
</tr>
<tr>
<td>Others (51)</td>
<td>134</td>
<td>133 (99.3)</td>
</tr>
</tbody>
</table>

**CONCLUSIONS**

The CRG has entered its fourth year and, since its inception as the TGMCC, has achieved much in the form of new records regarding the life-histories of Afrotropical Lepidoptera. With its scope expanding to include butterflies as well as parasitoids, and its profile and membership rising, it is hoped that it will result in an unprecedented amount of information about the immature stages of Afrotropical Lepidoptera becoming available in the near future, both to scientists for further research and to the interested public at large.

Rapid expansion of our knowledge of the early stages and host-associations of our Lepidoptera fauna is imperative in today’s situation of ever-dwindling natural habitats, increasingly under pressure from a
growing human population. Such knowledge, together with a sound taxonomic framework and accurate data recording, forms the basic tools needed for assessment of the conservation status of our Lepidoptera species, for it is only with the backing of sound conservation assessments that the plight of our Lepidoptera will be duly considered in future land-use planning. The LepSoc is currently undertaking such an assessment for southern Africa, through the Southern African Lepidoptera Conservation Assessment (Mecenero et al., 2015). Knowledge gained from the CRG project stands to be of immense value for this project, especially for species for which basic biological data are few or lacking completely.

Based on the success of the CRG project thus far, it is clear that the collaborative efforts of numerous enthusiastic naturalists, in combination with modern communication methods and proper scientific protocols, can achieve a rapid expansion of fundamental biological knowledge at low cost. We sincerely hope that this project, its objectives, methods and results, will find resonance in other regions of the world where biological information on Lepidoptera is similarly poor, particular in other African countries. We also hope that it will help inform conservationists, land managers and the public at large about the fascinating lives of these beautiful insects and assist in ensuring that they survive to be admired and enjoyed by many generations to come.

ACKNOWLEDGEMENTS

We thank first and foremost all our fellow caterpillar rearers for their contributions, as individually recognised in the master documents. Thanks are also due to our taxon specialists for identifying Lepidoptera falling within their sphere of expertise, who are likewise acknowledged at source.


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We would also like to thank the iSpot community (http://www.ispotnature.org) for supporting the CRG from its inception, and for always being very helpful when plant identifications were required. A number of our active participants are from this community.

Last but not least, we thank the editor of Metamorphosis, Dave Edge, for his ongoing support and encouragement throughout the CRG project and for acting as mentor to CRG members wishing to publish their observations, which exceeds the normal duties of an editor by far.

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