SHORT COMMUNICATION

EVALUATING THREATS AND CONSERVATION STATUS OF SOUTH AFRICAN ALOE

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Evaluating threats and conservation status of South African Aloe

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Abstract: South Africa is one of the biodiversity hotspots for Aloe in Africa. This makes it important to evaluate the conservation status and threats to this genus. The South African National Biodiversity Institute (SANBI) Red List was employed to evaluate these two factors. Results revealed that 44% of all species in this genus are of conservation concern with the majority of them facing threats. This study recommends that more attention such as strengthening the protection of these species and controlling the threats identified in this study should be given to species in this genus in terms of conservation management to reduce their risk of extinction.

Keywords: Asphodelaceae, biodiversity loss, extinction risk, hotspot, threatened species.

The genus Aloe belongs to the Asphodelaceae family (Cousins & Witkowski 2012). Biodiversity hotspots for this genus in Africa are located in Ethiopia, Madagascar and southern Africa (Grace 2009), which coincide with Africa’s main biodiversity hotspots (Daru et al. 2013).

Aloes are important to any ecosystems where they are found (Cousins & Witkowski 2012). Their nectar is a source of food for many insects (Nicolson & Nepi 2005; Botes et al. 2009a,b) and avians (Symes et al. 2008; Forbes et al. 2009). They also modulate harsh environmental conditions, which facilitate colonization of the environment by other plant taxa (Wabuyele & Kyalo 2008). Their mat-like root that is dense assist in preventing soil erosion (Smith & Van Wyk 2009).

Some species of this genus are traded commercially as cosmetics (Grace et al. 2015) and medicine (Bjorå et al. 2015). This has led Aloe to become threatened, with the majority of species in this genus being included in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Grace 2011). This implies that conservation of the species in this genus should be given a high priority, especially in areas that are hotspots of this genus (Klopper & Smith 2013).

This study evaluated the conservation status and threats of Aloe in South Africa to determine which species in this genus are threatened, and to determine factors responsible for their risk of extinction. Unlike some previous studies that mentioned the overall conservation status of the genus Aloe (e.g., Grace et al. 2009; Cousins & Witkowski 2012), this study showed the conservation status and threats each species of Aloe is facing using the South African National Red List, and also quantified in percentages species in this genus under different Red List categories and threat categories.

METHODS

This study used the SANBI Red List 2017 version to evaluate threats and conservation status of South
African Aloe. The following percentages were calculated: the species that are highly threatened, threatened and of conservation concern (Critically Endangered, Endangered, Vulnerable, Near Threatened, Rare, and Data Deficient); Aloe species that fall under different categories of threats (Habitat destruction, individual’s collection, invasive species occurrence, fire occurrence, overgrazing, and insect attack); species endemic and non-endemic to South Africa; threatened endemic species; and endemic species that are of conservation concern and different categories of threats (habitat destruction, individual’s collection, invasive species occurrence, fire occurrence, overgrazing, and insect attack) to endemic species.

RESULTS AND DISCUSSION

Endemic and non-endemic species of the genus Aloe in South Africa

A total of 125 taxa belonging to the genus Aloe were listed in the South African National Red List; 61.6% of species in the genus Aloe found in the South African National Red List are endemic, while 38.4% are non-endemic. Species endemism is an important factor to be considered in conservation because the loss of endemic species is of high significant impact in biodiversity loss in any geographic areas that they occur (Moraswi et al. 2019). A population survey of endemic taxa should be encouraged to determine their population size, density, and distribution in order to reveal their current population trend. This information will inform appropriate conservation measures, which are adaptive to local conditions.

Highly threatened, threatened, and species of conservation concern in South African Aloe

The various threat status categories of South African Aloe are: 52.8% (Least Concern), 10.4% (Rare), 2.4% (Data Deficient), 3.2% (Data Deficient, taxonomically problematic), 10.4% (Near Threatened), 11.2% (Vulnerable), 4% (Endangered), 5.6% (Critically Endangered), 44% are of conservation concern (Critically Endangered, Endangered, Vulnerable, Near Threatened, Rare, and Data Deficient). Species that are highly threatened are referred to as Critically Endangered (Williams et al. 2013) because they are at the brink of extinction. Aloe species in this study that falls into this category (Table 1) should be given quick conservation intervention such as preventing further collection by people, minimizing habitat loss, and improving on their regeneration potentials to prevent complete extirpation of their populations. Some plant species are not threatened, but can be flagged and given priority in terms of conservation, and thus be referred to as species of conservation concern (Victor & Keith 2004). Species of conservation concern in this study that are not threatened should be monitored to determine if they have become threatened (Table 1). For instance Data deficient taxa could possibly be threatened (Moraswi et al. 2019). This is why further efforts is required to obtain sufficient information about them in order to determine if they are threatened or not.

Threats to South African endemic and non-endemic Aloe species

Percentages of taxa in the genus Aloe in South Africa facing different types of threats are as follows: 41.6% are threatened by habitat destruction, 16.8% are threatened due to individual’s collection, 14.4% threatened by occurrence of invasive species, 5.6% are threatened because of fire occurrences, 11.2% are threatened by overgrazing, 0.8% threatened due to insect attack, while there are no threats found for 42.4% of the taxa. Aloe species are generally threatened by habitat destruction and collection by people (Klooper et al. 2009), a situation also reflected in this study. The collection by people are majorly due to medicinal uses and horticultural uses which might be affecting the wild population of these taxa (Grace 2011). Enforcement of regulation restricting the collections of these taxa should be more encouraged. It must be noted that a thorough assessment of those species for which their threats are unknown can significantly change the results pattern in the threat categories as presented above.

Threats to endemic species of South African Aloe

The results of the percentages of endemic species of South African Aloe facing different kind of threats are as follows: 57% are affected by habitat destruction, 23.4% affected by Individual’s collection, 17% are affected by invasive species, 9% by fire occurrence, 13% by overgrazing, while there are no threats found for 26% of the endemic species. Habitat destruction and collection by people still stood out among the threats to endemic South African Aloe species. It is recommended that species for whom their threats are not known (Table 1) be further assessed. Thus, it is possible that a reassessment of these species can alter the results presented above.

Conservation status of endemic species in South African Aloe

The results of the percentages of endemic Aloe...
Table 1. List of Aloe species in South Africa, their SANBI Red List Status, their endemism status and their threats on SANBI Red List.

| Species                          | SANBI Red List status | Endemism status | Threats                                                                 |
|----------------------------------|-----------------------|-----------------|-------------------------------------------------------------------------|
| Aloe aculeata Pole-Evans         | Least Concern         | Not endemic     | No threat                                                               |
| Aloe affinis A.Berger            | Least Concern         | Not endemic     | Habitat destruction                                                     |
| Aloe africana Mill.              | Least Concern         | Endemic         | Habitat destruction                                                     |
| Aloe albida (Stapf) Reynolds     | Near Threatened       | Not endemic     | Habitat destruction                                                     |
| Aloe alooides (Bolus) Druten      | Least Concern         | Endemic         | Habitat destruction                                                     |
| Aloe ammophilo Reynolds          | Least Concern         | Endemic         | No threat                                                               |
| Aloe angelica Pole-Evans         | Least Concern         | Endemic         | Habitat destruction                                                     |
| Aloe arborescens Mill.           | Least Concern         | Not endemic     | No threat                                                               |
| Aloe arenicola Reynolds          | Near Threatened       | Endemic         | No threat                                                               |
| Aloe barbara-jeppe T.A.McCoy & Lavranos | Near Threatened   | Endemic         | Habitat destruction                                                     |
| Aloe bergeriana (Dinter) Boatwr. & J.C.Manning | Data Deficient    | Not endemic     | Habitat destruction                                                     |
| Aloe bowies Schult. & J.H.Schuht. | Critically Endangered | Endemic         | Habitat destruction                                                     |
| Aloe braamvanwykii Gideon F.Sm. & Figueiredo | Endangered      | Endemic         | Habitat destruction                                                     |
| Aloe brandifloriensis Groenew.   | Least Concern         | Endemic         | Habitat destruction                                                     |
| Aloe brevifolia Mill. var. brevifolia | Vulnerable           | Endemic         | Habitat destruction, invasive presence, individual’s collection        |
| Aloe brevifolia Mill. var. depressa (How.) Baker | Data Deficient taxonomically problematic | Endemic         | Habitat destruction                                                     |
| Aloe broomi Schönland var. broomii | Least Concern         | Not Endemic     | No threat                                                               |
| Aloe broomi Schönland var. tarkaensis Reynolds | Rare                | Endemic         | No threat                                                               |
| Aloe buhrii Lavranos             | Vulnerable            | Endemic         | Individual’s collection, habitat destruction                           |
| Aloe castanea Schönland          | Least Concern         | Endemic         | No threat                                                               |
| Aloe chabaudi Schönland var. chabaudi | Least Concern         | Not endemic     | No threat                                                               |
| Aloe challisii Van Jaarsv. & A.E.van Wyk | Vulnerable           | Endemic         | Individual’s collection, invasive presence                             |
| Aloe chlorantha Lavranos         | Vulnerable            | Endemic         | Insect attack                                                           |
| Aloe chortoliriodes A.Berger var. chortoliriodes | Vulnerable          | Not endemic     | Habitat destruction, invasive presence, fire occurrences,             |
| Aloe chortoliriodes A.Berger var. woolliana (Pole-Evans) Glen & D.S.Hardy | Least Concern       | Endemic         | Habitat destruction, fire occurrences                                 |
| Aloe claviflora Burch.           | Least Concern         | Not endemic     | No threat                                                               |
| Aloe comosa Marloth & A.Berger   | Least Concern         | Endemic         | Individuals collection, habitat destruction                           |
| Aloe candystae Van Jaarsv. & P.Nel | Vulnerable           | Endemic         | Invasive presence                                                       |
| Aloe cooperi Baker               | Least Concern         | Not endemic     | Habitat destruction, overgrazing, invasive presence                    |
| Aloe craibii Gideon F.Sm.        | Critically Endangered | Endemic         | Individual’s collection, fire occurrences, invasive presence, habitat destruction |
| Aloe cryptopoda Baker            | Least Concern         | Not endemic     | No threat                                                               |
| Aloe dabanoriana Van Jaarsv. & P.Nel | Rare                | Endemic         | Individual’s collection                                                |
| Aloe dewetii Reynolds            | Least Concern         | Not endemic     | No threat                                                               |
| Aloe dominella Reynolds          | Near Threatened       | Endemic         | Habitat destruction, overgrazing, fire occurrences, invasive presence   |
| Aloe dyeri Schönland             | Least Concern         | Not endemic     | No threat                                                               |
| Aloe ecklonis Salm-Dyck          | Least Concern         | Not endemic     | Habitat destruction, invasive presence                                 |
| Aloe excelsa A.Berger var. excelsa | Least Concern         | Not endemic     | No threat                                                               |
| Aloe falcata Baker               | Least Concern         | Not endemic     | Individual’s collection, overgrazing                                   |
| Aloe ferox Mill.                 | Least Concern         | Not endemic     | Individual’s collection, habitat destruction, overgrazing             |
| Aloe fosteri Pillans             | Least Concern         | Endemic         | No threat                                                               |
| Species                                                                 | SANBI Red List status          | Endemism status | Threats                                      |
|------------------------------------------------------------------------|-------------------------------|-----------------|----------------------------------------------|
| Aloe fouriei D.S.Hardy & Glen                                          | Data Deficient taxonomically  | Endemic         | Habitat destruction, overgrazing             |
| Aloe framesii L.Bolus                                                  | Near Threatened               | Endemic         | Habitat destruction                          |
| Aloe garyepensis Pillans                                              | Least Concern                 | Not endemic     | No threat                                    |
| Aloe gerstenleri Reynolds                                             | Vulnerable                    | Endemic         | Habitat destruction, Overgrazing             |
| Aloe glauca Mill.                                                      | Least Concern                 | Endemic         | No threat                                    |
| Aloe globuligemma Pole-Evans                                          | Least Concern                 | Not endemic     | No threat                                    |
| Aloe gracilliflora Groenew.                                           | Least Concern                 | Endemic         | No threat                                    |
| Aloe grandidentata Salm-Dyck                                           | Least Concern                 | Not endemic     | No threat                                    |
| Aloe greatheadii Schönland var. davyna (Schönland) Glen & D.S.Hardy    | Least Concern                 | Not endemic     | No threat                                    |
| Aloe greenii Baker                                                    | Least Concern                 | Not endemic     | No threat                                    |
| Aloe hahnii Gideon F.Sm. & R.R.Klopper                                | Near Threatened               | Endemic         | Habitat destruction                          |
| Aloe hardyi H.F.Glen                                                  | Rare                          | Endemic         | No threat                                    |
| Aloe hereroensis Engl. var. hereroensis                                | Least Concern                 | Not endemic     | No threat                                    |
| Aloe humilis (L.) Mill.                                               | Least Concern                 | Endemic         | Habitat destruction, individual's collection |
| Aloe inconspicua Plowes                                                | Endangered                    | Endemic         | Habitat destruction, overgrazing             |
| Aloe integra Reynolds                                                 | Vulnerable                    | Not endemic     | Habitat destruction, invasive presence, fire occurrences |
| Aloe jepepeae Klopper & Gideon F.Sm.                                   | Least Concern                 | Endemic         | No threat                                    |
| Aloe kammellii Van Jaarsv.                                             | Rare                          | Endemic         | No threat                                    |
| Aloe karasbergensis Pillans                                           | Least Concern                 | Not endemic     | No threat                                    |
| Aloe knersvlakensis S.J.Marais                                        | Rare                          | Endemic         | No threat                                    |
| Aloe kniphofioides Baker                                              | Vulnerable                    | Endemic         | Habitat destruction, fire occurrences        |
| Aloe komaggoensis Kritzinger & Van Jaarsv.                             | Vulnerable                    | Endemic         | Individual's collection, habitat destruction, overgrazing |
| Aloe komatensis Reynolds                                               | Endangered                    | Not endemic     | Habitat destruction, invasive presence       |
| Aloe kouebokkeveldensis Van Jaarsv. & A.B.Low                          | Rare                          | Endemic         | No threat                                    |
| Aloe krapohliana Marloth                                              | Data Deficient                | Endemic         | Individual's collection, habitat destruction, overgrazing |
| Aloe lettyae Reynolds                                                 | Endangered                    | Endemic         | Habitat destruction, invasive occurrence, overgrazing, fire occurrences |
| Aloe lineanfolia A.Berger                                              | Near Threatened               | Endemic         | Habitat destruction, overgrazing             |
| Aloe lineata (Alton) Haw. var. lineata                                 | Least Concern                 | Endemic         | Habitat destruction                          |
| Aloe lineata (Alton) Haw. var. muirii (Marloth) Reynolds               | Least Concern                 | Endemic         | No threat                                    |
| Aloe littoralis Baker                                                  | Least Concern                 | Not endemic     | No threat                                    |
| Aloe longistyla Baker                                                 | Data Deficient                | Endemic         | Individual's collection, habitat destruction, overgrazing |
| Aloe lutescens Groenew.                                               | Least Concern                 | Not endemic     | No threat                                    |
| Aloe maculata All.                                                    | Least Concern                 | Not endemic     | No threat                                    |
| Aloe marlothii A.Berger subsp. marloithi                               | Least Concern                 | Not endemic     | No threat                                    |
| Aloe marlothii A.Berger subsp. orientalis Glen & D.S.Hardy             | Least Concern                 | Not endemic     | No threat                                    |
| Aloe melanacantha A.Berger                                             | Least Concern                 | Not endemic     | No threat                                    |
| Aloe meyeri Van Jaarsv.                                                | Rare                          | Not endemic     | No threat                                    |
| Aloe microacantho Haw.                                                 | Near Threatened               | Endemic         | Habitat destruction, invasive presence       |
| Aloe microstigma Salm-Dyck                                             | Least Concern                 | Not endemic     | No threat                                    |
| Aloe minimo Baker                                                     | Least Concern                 | Not endemic     | Habitat destruction                          |
| Aloe modesta Reynolds                                                 | Vulnerable                    | Endemic         | Habitat destruction, invasive presence       |
| Species                                      | SANBI Red List status | Endemism status | Threats                                      |
|----------------------------------------------|-----------------------|-----------------|----------------------------------------------|
| *Aloe monotropa* I.Verd.                     | Vulnerable            | Endemic         | Individual’s collection                      |
| *Aloe nodiflora* Reynolds                   | Least Concern         | Endemic         | Habitat destruction                          |
| *Aloe myriacantha* (Haw.) Schult. & J.H.Schult. | Least Concern         | Not endemic     | Invasive occurrences                         |
| *Aloe neilcrouchii* R.R.Klopper & Gideon F.Sm. | Endangered            | Endemic         | Habitat destruction                          |
| *Aloe neilcrouchii* R.R.Klopper & Gideon F.Sm. | Critically Endangered | Endemic         | Habitat destruction                          |
| *Aloe nubigena* Groenew.                    | Rare                  | Endemic         | Habitat destruction                          |
| *Aloe parvibracteata* Schönland            | Least Concern         | Not endemic     | No threat                                    |
| *Aloe parsonii* Schönland                   | Vulnerable            | Not endemic     | Overgrazing                                  |
| *Aloe pergerae* Schönland                   | Critically Endangered | Endemic         | Habitat destruction, individual’s collection |
| *Aloe perfoliata* L.                       | Least Concern         | Endemic         | No threat                                    |
| *Aloe petricola* Pole-Evans                 | Least Concern         | Endemic         | Habitat destruction                          |
| *Aloe pterophylla* Pillans                 | Rare                  | Endemic         | No threat                                    |
| *Aloe pictifolia* D.S.Hardy                | Rare                  | Endemic         | No threat                                    |
| *Aloe pluridens* Haw.                      | Least Concern         | Endemic         | No threat                                    |
| *Aloe pratensis* Baker                     | Least Concern         | Not endemic     | Habitat destruction, individual’s collection |
| *Aloe prionotheca* Pole-Evans              | Least Concern         | Not endemic     | Habitat destruction                          |
| *Aloe prinslooi* I.Verd. & D.S.Hardy       | Near Threatened       | Endemic         | Individual’s collection and invasive presence|
| *Aloe pruinosa* Reynolds                   | Vulnerable            | Endemic         | Habitat destruction, individual’s collection |
| *Aloe reinzi* Reynolds var. reinzi         | Near Threatened       | Endemic         | No threat                                    |
| *Aloe reinzi* Reynolds var. vernalis D.S.Hardy | Critically Endangered | Endemic         | Individual’s collection                      |
| *Aloe reynoldsi* Letty                     | Rare                  | Endemic         | Individual’s collection                      |
| *Aloe rupestris* Baker                     | Least Concern         | Not endemic     | No threat                                    |
| *Aloe saundersiae* (Reynolds) Reynolds     | Critically Endangered | Endemic         | Habitat destruction, overgrazing, fire occurrences |
| *Aloe sharanae* N.R.Crouch & Gideon F.Sm.  | Least Concern         | Not endemic     | Habitat destruction                          |
| *Aloe simii* Pole-Evans                    | Critically Endangered | Endemic         | Habitat destruction, Invasive presence       |
| *Aloe soutpansbergensis* I.Verd.           | Rare                  | Endemic         | Individual’s collection                      |
| *Aloe speciosa* Baker                      | Least Concern         | Endemic         | No threat                                    |
| *Aloe spectabilis* Reynolds                | Least Concern         | Endemic         | No threat                                    |
| *Aloe spinata* L.f.                        | Least Concern         | Not endemic     | No threat                                    |
| *Aloe striata* Haw.                        | Least Concern         | Endemic         | No threat                                    |
| *Aloe succotrina* Lam.                     | Least Concern         | Endemic         | No threat                                    |
| *Aloe sunderlinii* Reynolds                | Least Concern         | Not Endemic     | No threat                                    |
| *Aloe suprofoliata* Pole-Evans             | Least Concern         | Not Endemic     | No threat                                    |
| *Aloe thompsoniae* Groenew.               | Rare                  | Endemic         | No threat                                    |
| *Aloe thorncrofti* Pole-Evans             | Near Threatened       | Endemic         | Habitat destruction, Invasive presence       |
| *Aloe thraskii* Baker                      | Near Threatened       | Endemic         | Habitat destruction, individual’s collection |
| *Aloe vanbaleni* Pilans                    | Least Concern         | Not endemic     | No threat                                    |
| *Aloe vanrooynii* Gideon F.Sm. & N.R.Crouch | Least Concern         | Endemic         | No threat                                    |
| *Aloe verecunda* Pole-Evans                | Least Concern         | Endemic         | Habitat destruction                          |
| *Aloe voigtii* Reynolds                    | Close Threatened      | Endemic         | Habitat destruction                          |
| *Aloe vossii* Reynolds                     | Data Deficient taxonomically problematic | Endemic | Habitat destruction, fire occurrences, Invasive presence |
| *Aloe vryheidensis* Groenew.              | Data Deficient taxonomically problematic | Endemic | Habitat destruction                          |
| *Aloe zebrina* Baker                       | Least Concern         | Not endemic     | No threat                                    |
taxa in South Africa on SANBI Red List threat status categories are as follows: 32.4% (Least Concern), 5.2% (Data Deficient taxonomically problematic), 2.6% (Data Deficient), 15.6% (Rare), 15.5% (Near Threatened), 14.3% (Vulnerable), 5.2% (Endangered) and 9.1% (Critically Endangered); 28.6% of the endemic species in this genus are threatened (Critically Endangered, Endangered, Vulnerable); 62.3% of the endemic species are of conservation concern (Critically Endangered, Endangered, Vulnerable, Near Threatened, Rare, and Data Deficient). Endemic plant species are more vulnerable to extinction (Williams et al. 2013) because they are restricted to certain geographic regions and the total extirpation of their populations in that region automatically result in total extinction of the species (Bamigboye 2019). This is also being clearly revealed by the total extinction of their populations in that region for conservation (Critically Endangered, Endangered, Vulnerable, Near Threatened, Rare, and Data Deficient). Endemic plant species are more vulnerable to extinction (Williams et al. 2013) because they are restricted to certain geographic regions and the total extirpation of their populations in that region automatically result in total extinction of the species (Bamigboye 2019). This is also being clearly revealed by the total extinction of their populations in that region for conservation. Conservation status of species changes over time (Bamigboye et al. 2016). It is recommended that South African Aloe should be further evaluated to see if they have become more threatened in recent times or not. A recent evaluation will also reveal if the ones that are not threatened on SANBI Red List are now threatened.

CONCLUSION
This study presents the current conservation status, endemic status and threats that each species of Aloe in South African Red List are facing. It also quantifies the percentages of species in this genus that fall into different SANBI Red List categories, threat categories, and endemism categories. This study provides information on the species of Aloe in South Africa that need more conservation attention. For instance the Critically Endangered species in this study that are all endemic species (Table 1) can be given higher priorities for conservation. Conservation status of species changes over time (Bamigboye et al. 2016). It is recommended that South African Aloe should be further evaluated to see if they have become more threatened in recent times or not. A recent evaluation will also reveal if the ones that are not threatened on SANBI Red List are now threatened.

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Use of an embedded fruit by Nicobar Long-tailed Macaque Macaca fascicularis umbrosus: II. Demographic influences on choices of coconuts Cocos nucifera and pattern of forays to palm plantations
— Sanyatan Das, Rebekah C. David, Ashvita Anand, Saurav Harikumar, Rubina Rajan & Mewa Singh, Pp. 16407–16423

Communications

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— Dago Dorji, Jambay, Ju Lian Chong & Tsering Dorji, Pp. 16424–16433

A checklist of mammals with historical records from Darjeeling-Sikkim Himalaya landscape, India
— Thangsuanlian Naulak & Sunita Pradhan, Pp. 16434–16459

Golden Jackal Canis aureus Linnaeus, 1758 (Mammalia: Carnivora: Canidae) distribution pattern and feeding at Point Calimere Wildlife Sanctuary, India
— Nagarajan Baskaran, Ganesan Karthikeyan & Kamaraj Ramkumaran, Pp. 16460–16468

Suppression of ovarian activity in a captive African Lion Panthera leo after deslorelin treatment
— Daniela Paes de Almeida Ferreira, Priscila Viau, Andrew Rosenfield, & Mewa Singh, Pp. 16469–16477

Spatial aggregation and specificity of incidents with wildlife make tea plantations in southern India potential buffers with protected areas
— Suman Pratihar & Niloy Mandal, Pp. 16480–16484

Innovative way of human-elephant competition mitigation
— Sanjit K. Saha, Pp. 16491–16501

New locality records and call description of the Resplendent Shrub Frog Raorchestes resplendens (Amphibia: Anura: Rhacophoridae) from the Western Ghats, India
— Sandeep Das, K.P. Rajkumar, K.A. Sreejith, M. Royaltata & P.S. Easa, Pp. 16502–16509

First record of a morphologically abnormal and highly metal-contaminated Spotback Skate Atlantoraja castelnouai (Rajiformes: Arhynchobatidae) from southeastern Rio de Janeiro, Brazil
— Rachel Ann Hauser-Davis, Márcio L.V. Barbosa-Filho, Lucia Helena S. de S. Pereira, Catarina A. Lopes, Sérgio C. Moreira, Rafael C.C. Rocha, Tatiana D. Saint’Pierre, Paula Baldassin & Salvatore Siciliano, Pp. 16510–16520

Butterfly diversity in an organic tea estate of Darjeeling Hills, eastern Himalaya, India
— Aditya Pradhan & Sarala Khaling, Pp. 16521–16530

Freshwater decapods (Crustacea: Decapoda) of Palair Reservoir, Telangana, India
— Sudipta Mandal, Deepa Jaiswal, A. Narahari & C. Shiva Shankar, Pp. 16531–16547

Diversity and distribution of figs in Tripura with four additional records
— Smita Debbarma, Bipvalor Baksh, Biswajit Baishnab, B.K. Datta & Koushik Majumdar, Pp. 16548–16570

Notes

Reinstatement of Pimpinella Katejensis R.S. Rao & Hemadri (Apiaceae), an endemic species to Maharashtra with notes on its taxonomy and distribution
— V.J. Zacharias & Boby Jose, Pp. 16622–16627

New records of hoverflies of the genus Volucella Geoffroy (Diptera: Syrphidae) from Pakistan along with a checklist of known species
— Muhammad Asghar Hassan, Imran Bodlah, Anjum Shehzad & Noor Fatima, Pp. 16632–16635

A new species of Dillenia (Angiosperms: Dilleniaceae) from the Eastern Ghats of Andhra Pradesh, India
— J. Swamy, L. Rasingam, S. Nagaraju & Pooja R. Mane, Pp. 16636–16640

Puccinia duthiei Ellis & Tracy: a new host record on Pimpinella Katejensis R.S. Rao & Hemadri (Apiaceae), an endemic species to Maharashtra
— S.M. Deshpande, S.D. Kulkarni, R.B. More & K.V.C. Gosavi, Pp. 16641–16643

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— J. Swamy, L. Rasingam, S. Nagaraju & Pooja R. Mane, Pp. 16636–16640

Publisher & Host

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A preliminary checklist of spiders (Araneae: Arachnida) in Jambughoda Wildlife Sanctuary, Panchmahal District, Gujarat, India
— Reshma Solanki, Manju Siliwal & Dolly Kumar, Pp. 16576–16596

Notes

The first record of Montagu’s Harrier Circus pygargus (Aves: Accipitridae) in West Bengal, India
— Suman Pratihar & Niloy Mandal, Pp. 16620–16621

An account of snake specimens in St. Joseph’s College Museum Kozhikode, India, with data on species diversity
— V.J. Zacharias & Boby Jose, Pp. 16622–16627

Notes on the occurrence of a rare pufferfish, Chelonodontops leopardus (Day, 1878) (Tetraodontiformes: Tetraodontidae), in the freshwaters of Payaswini River, Karnataka, India
— Priyankar Chakraborty, Subhrendu Sekhar Mishra & Kranti Yardi, Pp. 16628–16631

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— Muhammad Asghar Hassan, Imran Bodlah, Anjum Shehzad & Noor Fatima, Pp. 16632–16635

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— J. Swamy, L. Rasingam, S. Nagaraju & Pooja R. Mane, Pp. 16636–16640

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— S.M. Deshpande, S.D. Kulkarni, R.B. More & K.V.C. Gosavi, Pp. 16641–16643

Puccinia duthiei Ellis & Tracy: a new host record on Chrysopogon velutinus from India
— Suhas Kundlik Kamble, Pp. 16644–16646