Utilization of orchids of Wallacea region and implication for conservation

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Abstract. Orchids are characterized by attractive flowers and morphologically unique plants, thus, they are much appreciated as ornamental plants. Apart from as ornamental plants, orchids are known to have other uses; for food, vegetables, herbal medicines, cosmetics, and other uses. The present study aimed to reveal a wide range of utilization of orchids of the Wallacea region. There were 47 species of orchids of the Wallacea region belong to 32 genera that have been utilized in a wide range of uses, with one species that could have multiple uses. The utilization of orchids of the Wallacea region was for food (4 species), vegetable (1 species), spices (1 species), herbal medicines (37 species), cosmetics (3 species), and other uses (7 species). Data on the utilization of orchids of the Wallacea region can support bioprospecting to find new bioresources for food alternatives, herbal medicines, and other useful products. In the utilization of orchids as bioresources, the conservation approach is highly recommended to ensure the long-term survival of the orchids and for the sustainable use of the orchids. Of these 47 orchid species that have been utilized, two species are endemic to the Wallacea region (Dendrobium facifeum and D. utile) that should receive priority setting in the conservation planning.

1. Introduction
Plants have essential roles in human life and have been widely used for many purposes, for food, clothes, shelter, medicines, ornamental plants, and other essential uses [1,2]. A wide range of species from many plant families have been utilised to meet human daily needs. For example, Oryza sativa L, Zea mays L. (Poaceae) have been used as food; Gossypium including G. hirsutum, G. barbadense, G. arboreum, and G. herbaceum (Malvaceae) have been utilised as bioresources to make clothes. Furthermore, Tectona grandis (Lamiaceae) anda wide range of trees from other families have been used to make shelters and housings, and various herbs (for instance Zingiberaceae) have been used for herbal medicines to treat a wide range of ailments and illnesses.

Orchidaceae is one of the biggest plant families consisted of approximately 25,000-30,000 species and well known as ornamental plants as the family has unique and attractive flowers and possess morphologically-unique forms [3-5]. For instance, many orchid species from genera Phalaenopsis, Dendrobium, and Cymbidium have attractive and showy flowers and have been used as ornamental plants. Moreover, Macodes and Anoectochilus have morphologically unique leaves with conspicuous patterned leaves which are also outstanding as ornamental plants. Apart from as ornamental plants, orchids have been used for other purposes such as for food, vegetables, herbal medicines, cosmetics, and other uses [6-11].
The present study aimed to reveal utilization of orchids focusing on orchids of Wallacea region, a unique region that is well known with the transition zone of flora and fauna between two regions (i) the Sundaland region (Malay Peninsula, Sumatra, Borneo, Java, and Bali) in the west and (ii) Australian region in the east. The region comprised three main island groups including the Lesser Sunda island, Maluku, and Sulawesi, and the surrounding many smaller islands [12-13].

Information of utilization of orchid of Wallacea region is important to support bioprospecting to find new bioresources that can be developed as new alternatives for food, herbal medicines, and other useful products in a large scale in this region. However, in the utilization of orchids, we need to consider the long-term survival of the species and conservation approach is required. Overcollection of orchids from natural habitats for economical purposes should be avoided as it can lead to the population decline and disappearance of the orchids. The principle of the balance between utilization and conservation of orchids is important to be implemented.

Furthermore, Orchidaceae is known as plant family that is susceptible to environmental change and many species within the family are listed under IUCN Red List alarming for conservation priority. This is linked to the intrinsic characters of Orchidaceae as the establishment, persistence, and survival of orchids in their natural habitats highly rely on the other organisms (mycorrhizal fungi and pollinators). Mycorrhizal fungi are required to support seed germination and seedling development as mycorrhizal fungi are able to take up nutrients from soil and substrates and transfer a proportion of nutrients to the orchid seeds to germinate and to develop into seedlings [14-15]. Pollinators (including insects, birds, and other pollinators) have an important role in orchid pollination for fruit and seed set. The loss of mycorrhizal fungi and pollinators because of environmental change can lead to the disappearance of the orchid associates.

Therefore, with the potential uses of orchids to be developed into bioresources for many purposes and the susceptibility of orchid to environmental change, it is highly recommended to consider the long term survival of the orchids through orchid conservation. In the present study, utilisation of orchids in Wallacea region and the implication for conservation is elucidated.

2. Methods
Utilisation of orchids of Wallacea regions (Lesser Sunda Island Maluku, Sulawesi, and the surrounding smaller islands) are recorded through scientific literatures. The utilisation of orchids was then classified based on the uses as food, vegetables, flavouring, herbal medicines, cosmetics, and other uses.

3. Results and Discussion
An estimated of 47 orchid species of Wallacea region belong to 32 genera have been utilised for many purposes (Table 1).

| Genus        | Number of species | Species                                               |
|--------------|-------------------|-------------------------------------------------------|
| Acriopsis    | 1                 | Acriopsis javanica Reinw. ex Blume;                   |
| Aerides      | 1                 | Aerides odorata Lour.                                  |
| Anoectochilus| 1                 | Anoectochilus reinwardtii Blume.                      |
| Arachnis     | 1                 | Arachnis flos-aeris (L.) Rchb.f                       |
| Arundina     | 1                 | Arundina graminifolia (D.Don) Hochr.                  |
| Bromheadia   | 1                 | Bromheadia finlaysoniana (Lindl.) Miq.                |
| Calanthe     | 1                 | Calanthe triplicata (Willemet) Ames                   |
| Cleisostoma  | 1                 | Cleisostoma williamsonii (Rchb.f.) Garay             |
| Corymborkis  | 1                 | Corymborkis veratrifolia (Reinw.) Blume               |
| Cymbidium    | 2                 | Cymbidium bicolor Lindl.; C. lancifolium Hook.        |
3.1. Utilization of orchids of Wallacea region

Orchids of Wallacea region have been utilised for food (4 species), vegetable (1 species), spices (1 species), herbal medicines (37 species), cosmetics (3 species), and other uses (7 species). Data of the utilisation of orchids can support bioprospecting to find new bioresources for food, vegetable, spices, cosmetics, and other uses. The utilisation of orchids of Wallacea regions are described below.

3.2. Food

There are four plant species that have been utilised for food including Goodyera rubicunda, Habenaria multipartita, H. rumphii, and Nervilia aragoana (Table 2). Goodyera rubicunda has large tubers (diameter 10 cm -15 cm) containing low calories of carbohydrates (Silalahi and Nisyawati, 2015) which are potential as food source and suitable for people with diabetes mellitus and obesity. Tubers of Habenaria multipartita and Nervilia aragoana are also edible that are potential to be developed as food alternatives underpinning food security and diversification, while tuber of Habenaria rumphii can be processed into delicious jams, which are prospective to be developed in various cuisines (Table 2). Further research is required for the development of these orchids as bioresources for food.
### Table 2. Orchids of Wallacea region utilised as food

| Name                                         | Parts used | Uses                                                                 | References |
|----------------------------------------------|------------|----------------------------------------------------------------------|------------|
| *Goodyera rubicunda* (Blume) Lindl.          | Tuber      | The tubers are potential as a food source, containing low carbohydrate calories | [16]       |
| *Habenaria multipartita* Bl. Ex Kraenzl        | Tuber      | The tubers are edible                                                | [17]       |
| *Habenaria rumphii* (Brongn.) Lindl.          | Tuber      | The tubers are processed into delicious jams or candy                | [17,18]    |
| *Nervilia aragoana* Gaudich                   | Tuber      | The tubers are edible, chewed to quench the thirst.                  | [19]       |

#### 3.3. Vegetable

There is 1 species that has been used as vegetable. Leaves of *P. amabilis*, especially young leaves can be used as vegetables. Utilisation of leaves of *P. amabilis* can be promoted as a vegetable alternative (Table 3).

### Table 3. Orchids of Wallacea region utilised as vegetable

| Name                                         | Parts used | Uses                                                                 | References |
|----------------------------------------------|------------|----------------------------------------------------------------------|------------|
| *Phalaenopsis amabilis* (L.) Blume           | Leaf       | The young leaves consumes as fresh (in salad) or cooked vegetables    | [18]       |

#### 3.4. Spices

There is 1 species that has been used as spices, *Renanthera moluccana*. The young leaves of *R. moluccana* taste sour, that can be used as a flavouring, alone or together with other food acids (Table 4). The young leaves of this orchid can be one of bioresources to acidify food.

### Table 4. Orchids of Wallacea region utilised as spices

| Name                                         | Parts used | Uses                                                                 | References |
|----------------------------------------------|------------|----------------------------------------------------------------------|------------|
| *Renanthera moluccana* Blume                 | Leaf       | The young leaves taste sour, used to be pickled in vinegar, alone or together with other food acids | [18,20]    |

#### 3.5. Herbal medicines

There are 37 orchid species that have been utilised as herbal medicines to treat a wide range of various ailments and diseases including fever, cough, headache, tuberculosis, bronchitis, hepatitis, malaria, cancer, rheumatism, arthritis, bone fracture, diabetes mellitus, diarrhoea, dysentery, wounds, snake bite, insect bite, boils, and other ailments (Table 5). *Acriopsis javanica* (root and leaf), *Anoectochilus reinwardtii* (whole plant), *Corymborkis veratrifolia* (leaf), *Macodes petola* (whole plant), and *Spiranthes sinensis* (whole plant) can be used to treat fever. Cough can be treated by *Nervilia aragoana* (whole plant) and *Spiranthes sinenis* (whole plant). *Spiranthes sinensis* (tuber) can be used to treat headache.

Tuberculosis can be treated by *Aerides odorata* (leaf), *Eulophia spectabilis* (tuber), *Nervilia aragoana* (whole plant). *Eulophia spectabilis* (tuber) can be used to treat bronchitis. Hepatitis can be treated by *Arundina graminifolia* (root), while malaria can be treated by *Tropidia curculigoides* (whole plant combined with Ardisia).
Cancer can be treated by *Anoectochilus reinwardtii* (whole plant), *Macodes petola* (whole plant), and *Pholidota articulata* (root). Tumours can be treated by *Geodorum densiflorum* (bulb) and *Arundina graminifolia* (root).

*Arundina graminifolia* (root), *Cymbidium bicolor* (leaf), *Malaxis rhedii* (tuber), *Oberonia mucronata* (whole plant), *Pholidota imbricata* (pseudobulb), *P. pallida* (root and pseudobulb), and *Cymbidium bicolor* (leaf) can be used to treat rheumatism, while arthritis can be treated by *Aerides odorata* (root, combined with *Azadirachta indica* bark and *Saraca asoca* root), *Arundina graminifolia* (root), *Cymbidium bicolor* (leaf), and *Polystachya concreta* (tuber). Bone fracture can be treated by *Arundina graminifolia* (bulbous stems), *Dendrobium eriiflorum* (pseudobulb), *D. heterocarpum* (pseudobulb), *Oberonia mucronata* (whole plant), *Phaius tankervilleae* (whole plant, combined with ginger), *Pholidota articulata* (whole plant), and *P. imbricata* (leaf and root). Diabetes mellitus can be treated by *Arundina graminifolia* (root), *Goodyera rubicunda* (tuber), and *Phaius callosus* (tuber).

*Diarrhoea* can be treated by *Tropidia curculigoides* (root). *Grammatophyllum scriptum* (whole plant) and *Phaius tankervilleae* (whole plant combined with ginger) can be used to treat dysentery.

Wounds can be treated by *Aerides odorata* (leaf), *Dendrobium fimbriatum* (leaf), *Geodorum densiflorum* (root), *Nervilia aragona* (leaf/tuber), *Phaius tankervilleae* (pseudobulb, root, leaf), and *Spiranthes sinensis* (tuber). *Geodorum densiflorum* (root), *Malaxis rhedii* (tuber) can be used to treat insect bites, while snake bites can be treated by *Arundina graminifolia* (root) and *Dendrobium plicatile* (whole plant combined with other drugs). Boils can be treated by *Aerides odorata* (leaf), *Dendrobium crumenatum* (leaf and fruit), *Eulophia spectabilis* (leaf and fruit), *Eulophia spectabilis* (whole plant), *Oberonia lycopodioides* (leaf), *Pecteilis susannae* (tuber), and *Phaius tankervilleae* (pseudobulb, root, leaf). (Table 4). Further research is required to investigate bioactive compounds in the orchids to develop new drug formulation to treat a wide range of ailments and illnesses.

**Table 5. Orchids of Wallacea region used as herbal medicines**

| Name | Parts used | Uses | References |
|------|------------|------|------------|
| *Acriopsis javanica* Reinw. ex Blume | Root and leaf, pseudobulb | The roots and the leaves to treat fever. The pseudobulbs to treat fever, hypertension, and earache | [17,18, 21] |
| *Aerides odorata* Lour. | Root, leaf, fruit | The roots combined with *Azadirachta indica* barks and *Saraca asoca* roots to treat joint pain and swelling. The leaves to treat tuberculosis, boils, nose and ear diseases, cuts and wounds. The fruits to treat wounds. | [22- 25] |
| *Anoectochilus reinwardtii* Blume. | Whole plant | The whole plant to treat fever and cancer, and as tonic and aphrodisiac | [16] |
| *Arundina graminifolia* (D.Don) Hochr. | Rhizome, root | The rhizomes have anti-bacterial activity. The roots to treat body ache, joint pain, rheumatism; diabetes, tumor, hyperliposisis, hepatitis, and snake bites. The bulbous stems to treat hand and feet fractures. | [22-24, 26-28] |
| *Bromheadia* | Root | The roots mixed with *Lavanga* | [29] |
| Species                        | Parts Used                      | Uses                                                                 |
|-------------------------------|--------------------------------|----------------------------------------------------------------------|
| Finlaysoniana (Lindl.) Miq.   |                                 | Roots and Eurycoma longifolia Jack roots to treat back ache           |
| Calanthe triplicata (Willemet) Ames | Root, flower                  | The roots combined with Areca cathecu, Myristica fragrans, and Zingiber officinale to treat diarrhoea. The flowers to treat caries |
| Cleisostoma williamsonii      | Whole plant                    | The whole plant is astringent                                         |
| Corymborkis veratrifolia      | Leaf                           | The leaves are emetic and to treat fever, especially in children      |
| Cymbidium bicolor Lindl.      | Root and flower                | The roots to treat epilepsy and mental depression. The leaves to treat joint swelling, rheumatic pains and skin inflammation. The flowers to treat burnt face |
| Dendrobium crumenatum Sw.     | Leaf, fruit, pseudobulb, tuber  | The leaves and the fruits to treat boils and pimples. The pseudobulbs to treat infected ears. The tubers to treat hematemesis |
| Dendrobium eriiflorum Griff.  | Pseudobulb                     | The pseudobulbs are tonic, and to treat fractured and dislocated bones |
| Dendrobium fimbriatum Hook.   | Whole plant, leaf              | The whole plant to treat liver upset and nervous debility. The leaves to treat cuts and wounds |
| Dendrobium heterocarpum Wall.ex. Lindl. | Pseudobulb                     | The pseudobulbs to treat fractured and dislocated bones |
| Dendrobium plicatile Lindl.   | Whole plant, fruit             | The whole plant is stimulant and tonic, cold, mucilaginous, light, strengthening, and to treat disorders of the bile, blood and phlegm. The whole plant in combination with other drugs to treat snake bite and scorpion sting. The whole plant is mixed in bathing water to treat intermittent fever. The fruits are aphrodisiac. |
| Dendrobium purpureum Roxb.    | Leaf, stem                     | The leaves and the stems to treat infected nails                      |
| Dendrobium salaccense (Blume) Lindl. | Leaf                         | The leaves to treat stomach ache                                      |
| Eulophia spectabilis (Denst.) Suress | Tuber; whole plant, leaf        | The tubers to treat tuberculosis glands in neck tumours, bronchitis, as blood purifier, |
**Geodorum densiflorum** (Lam.) Schltr.

Root, bulb, tuber

The roots to treat irregular menstrual cycle, insect bite and wounds. The roots to treat goat in diarrhoeal symptoms. The bulbs to treat skin inflammation, tumours, and abscesses. The tubers to treat intermittent fever in cattle. [22,23,35]

**Goodyera rubicunda** (Blume) Lindl.

Tuber

The tubers are tonic, and to treat diabetes mellitus [16,18]

**Grammatophyllum scriptum** (L.) Blume.

Pseudobulb

The pseudobulbs combined with *Curcuma* to treat infected nails. The pseudobulbs combined with ginger are vermifuge, and to treat dropsy, aphthae, and beriberi. The seeds to treat dysentery. [17,18,36]

**Herminium lanceum** (Thu nb. ex Sw.) Vuijk

Whole plant

The whole plant to treat suppressed urination [24,37,38]

**Liparis conylobulbon** Rchb.f.

Pseudobulb

The pseudobulbs to treat constipation and obesity [17,18]

**Malaxis rheedii** Sw.

Tuber

The tubers to treat insect bites and rheumatism [23]

**Nervilia aragoana** Gaudich

Leaf, tuber, whole plant,

The leaves and the tubers to treat wounds. The leaves as a protective medicine after childbirth. The tubers to treat red eye and various ailments. The whole plants to treat bruises, swellings, coughs, tuberculosis, and scrofula [19,23,26,39]

**Oberonia lycopodioides** (J.Koenig) Ormerod

Leaf

The leaves for poulticing to boils [23,40]

**Oberonia mucronata** (D.Don) Ormerod & Seidenf.

Whole plant

The whole plant is detoxicant, diuretic, and to treat rheumatism and to promote blood circulation, to treat inflammations of the bladder and ureter, bruises and fractures [41]

**Pecteilis susannae** (L.) Raf.

Tuber

The tubers to treat boils [23]
| **Peristylus goodyeroides** (D.Don) Lindl. | Tuber | The tubers are tonic | [23] |
| **Phaius callosus** (Blume) Lindl. | Tuber | The tubers to treat diabetes mellitus | [16] |
| **Phaius tankervilleae** (Banks) Blume | Pseudobulb, whole plant, root, leaf, flower | The whole plant with wild ginger to treat dysentery and bone fractures. The pseudobulbs, the roots and the leaves to treat boils, infected wounds, abscesses, hand and leg swelling, and abscess. The flowers are as an aid to conception. | [18,22,23] |
| **Pholidota articulata** Lindl. | Whole plant, pseudobulb, shoot, root, fruit | The whole plant is tonic, and to treat bone fractures. The pseudobulbs to treat dislocated bones. The shoots have antibacterial activity. The roots to treat cancer. The fruits to treat skin ulcers and skin eruptions. | [23-26,37] |
| **Pholidota imbricata** Lindl. | Whole plant, pseudobulb, leaf, root | The whole plant is tonic. The pseudobulbs to treat abdominal pain and rheumatism. The leaves and the roots to treat bone fractures | [22-24,26] |
| **Pholidota pallida** Lindl. | Root, pseudobulb | The roots and the pseudobulbs to treat naval pain, abdominal pain, and rheumatic pain. The roots and the pseudobulbs to induce sleep | [24] |
| **Polystachya concreta** (Jaqc.) Garay & H.R.Sweet | Tuber | The tubers to treat arthritis. | [23] |
| **Spiranthes sinensis** (Pers.) Ames | Whole plant, root, stem, flower, tuber | The whole plants to treat intermittent cough, fever, and cold. The roots and the stems to treat sores. The flowers mixed with mustard oil to treat skin eruption. The tubers are tonic and energizer, and to treat sour throat, wounds, and headaches. The tubers mixed with salt to treat swelling. | [24-26, 37, 42,43] |
| **Tropidia curculigoides** Lindl. | Root, whole plant | The roots to treat diarrhoea. The whole plant combined with *Ardisia* to treat malaria | [22,23,44] |
| **Zeuxine strateumatica** (L.) Schltr. | Tuber, root | The tubers are tonic | [22-26] |
3.6. Cosmetics
There are three orchid species that have been used as cosmetics (Table 6). *Cymbidium lancifolium* and *Phalaenopsis amabilis*, the whole plants are used as emollient and skin conditioning components of cosmetic products, while *Dendrobium salaccense*, the leaf is used as the scent in cosmetics and for hair perfume. *Cymbidium bicolor*, the flower is used to remove face dark spots. Further research is also required in the utilization of orchids in cosmetics.

**Table 6.** Orchids of Wallacea region utilised as cosmetics

| Name                      | Parts used       | Uses                                                | References |
|---------------------------|------------------|-----------------------------------------------------|------------|
| *Cymbidium bicolor* Lindl.| Flower           | Flower to treat dark spots on skin                  | [31]       |
| *Cymbidium lancifolium* Hook. | (whole plant; extracted) | Antioxidant, astringent, emollient and skin-conditioning component of cosmetic products | [10]       |
| *Phalaenopsis amabilis* (L.) Blume | (whole plant; extracted) | Humectant component of cosmetic products | [10]       |

3.7. Other uses
There are seven orchid species that have been used for other uses (Table 7). Orchids have been used in cultural and ritual ceremony including *Arachnis flos-aeris* (flower) and *Corymborkis veratrifolia* (whole plant). Orchids also have been used in the making of handicrafts, including *Dendrobium acuminatissimum*, *D. faciferum* and *D. utile*. *Dendrobium utile* is the most widely used orchid as raw materials to make handicrafts. The pseudobulbs of the species are split, and flattened forming wet strips. The wet strips were then coiled around a log. When they are dried, weaving materials that are smooth, glossy, polished, and golden yellow-colored are obtained. Subsequently, they are woven into bags, baskets, hats, mats and other handicrafts that look luxurious. The materials and the handicrafts obtained from the pseudobulbs of *D. utile* are expensive as the materials are scarce and the look is luxurious. *Dendrobium acuminatissimum* and *D. faciferum* also have been used as raw materials in woven handicrafts, however their quality is inferior to *D. utile* (18, 45, 46). Furthermore, *Spathoglottic plicata*, the leaves have been used as wraps and the powdery seeds as a substitute of face powder for children (Table 7).

**Table 7.** Orchids of Wallacea region utilised as other uses

| Name                                               | Parts used       | Uses                                              | References |
|-----------------------------------------------------|------------------|---------------------------------------------------|------------|
| *Arachnis flos-aeris* (L.) Rchb.f                   | Flower           | Flower for cultural ceremony                      | [47]       |
| *Corymborkis veratrifolia* (Reinw.) Blume           | Whole plant      | often found on old graves indicating ritual uses   | [30]       |
| *Dendrobium acuminatissimum* Blume (Lindl.)         | stem             | Stem for weaving materials                         | [18]       |
| *Dendrobium faciferum* J.J.Sm.                      | stem             | Stem for weaving materials                         | [17]       |
| *Dendrobium utile* J.J.Sm.                          | (pseudobulb)     | Used as arm bands and weaving in handcraft for wallet, mats, baskets, handbags, hats | [18,46]    |
| *Grammatophyllum scriptum* (L.) Blume.              | Flower           | The pale greenish flowers used as women’s hair ornaments | [18]       |
3.8. Implication for Conservation

The present study has revealed a wide array of utilisation of orchids, i.e., for food, vegetable, spices, herbal medicines, cosmetics, and other uses. In the utilisation of orchids, we need to consider a long-term survival of orchids. Overcollection of orchids from their natural habitats to be used in various purposes for orchid commercialisation should be avoided as this will lead to the population decline and extinction of the orchids in the natural habitats.

Furthermore, orchids are vulnerable to environment change as orchids highly depend on the other organisms (mycorrhizal fungi and pollinators). Mycorrhizal fungi have important role in the orchid germination and seedling development, as mycorrhizal fungi can supply a proportion of nutrients to the orchid seeds that lack of nutrient reserves. Furthermore, pollinators (such as insects) are essential in the orchid pollination for fruit and seed set. The loss of mycorrhizal fungi and pollinators in the orchid natural habitats because of environment change can cause the loss of orchids. Therefore, orchid conservation is important to protect the orchids from becoming extinct.

Moreover, in the conservation planning, priority setting and high attention should be given to the endemic orchids as they have a narrow range of distribution. Of 47 orchid species of Wallacea region that have been utilised, two species are endemic to Wallacea region (*Dendrobium faciferum* is endemic to Lesser Sunda Island, Maluku, and Sulawesi, while *D. utile* is endemic to Maluku and Sulawesi).

*Dendrobium utile* has reportedly experienced population decline and becoming disappeared in South East Sulawesi because of the massive utilization of the pseudobulbs to make various forms of handicraft. Furthermore, habitat conversion and land use change has impacts on the decline of distribution and population of the species [46]. For the survival of orchids, especially endemic orchid that have been widely utilised, such as *D. utile*, a high priority in the conservation is required to protect the orchid from becoming extinct.

The recommendation of the conservation of the species including (i) propagation of the orchids to generate a large number of plants. Further research is required to find a protocol for effective propagation of *D. utile*. Previous studies have found protocols of propagation of some orchids, such as *Dendrobium taurulinum* [48] and *Dendrobium lasianthera* [49]. The protocol of orchid propagation is important for effective and efficient propagation to obtain a large number of plants in relatively short time. (ii) Study of the mycorrhizal fungi and the pollinator associated with *D. utile* should be conducted as orchids are characterised by the dependence on the mycorrhizal fungi and pollinators for their survival. (iii) involvement of community in the conservation of *D. utile* to protect *D. utile* from becoming extinct.

Overall, the present study has revealed utilization of orchids of Wallacea region as well as recommendation of conservation of orchids for the long term survival of the orchids for the balance between utilization and conservation of orchids in the concept of sustainable use of the orchids. Further research is required in the sustainable use of orchids in the form of utilization of orchids for more useful products that can increase socio-economic level of the community, as well as conservation of orchids to protect the orchids and for the long-term survival of the orchids.

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