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Keterangan foto cover depan: Beberapa jenis makrofungi yang dijumpai di Cagar Alam Tangale
(*Notes of cover picture*): (*Some of the macrofungi species were found in Tangale Nature Reserve*) sesuai dengan
halaman 109 (*as in page 109*).

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THE MACROFUNGI DIVERSITY AND THEIR POTENTIAL UTILIZATION IN TANGALE NATURE RESERVE GORONTALO PROVINCE

[Keragaman Jenis Jamur Makro dan Peluang Pemanfaatannya di Cagar Alam Tangale
Provinsi Gorontalo]

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ABSTRAK

Cagar Alam Tangale merupakan salah satu kawasan konservasi di Provinsi Gorontalo yang menyimpan keragaman hayati khas wilayah Wallacea, termasuk keragaman jenis jamur makro yang saat ini masih sangat terbatas informasinya. Penelitian ini bertujuan untuk mengidentifikasi keragaman jenis jamur makro di CA. Tangale dan peluang potensi pemanfaatannya. Penelitian menggunakan *cruise method* dengan melakukan identifikasi terhadap jamur makro yang ditemukan di sepanjang jalur yang telah ada. Karakteristik yang dicatat meliputi warna tubuh buah, diameter, bentuk batang, panjang dan diameter batang, lamela, tipe lamela, pori, cincin, volva, tipe volva serta substrat tempat tumbuhnya jamur makro tersebut. Selanjutnya data dianalisis secara deskriptif. Hasil penelitian menunjukkan bahwa di CA. Tangale teridentifikasi sebanyak 28 jenis jamur makro yang digolongkan ke dalam divisi Ascomycota dan Basidiomycota. Dua puluh delapan jenis makrofungi dapat dikelompokkan ke dalam 16 suku dan delapan ordo yakni Pezizales, Agaricales, Auriculariales, Boletales, Cantharellales, Gomphales, Polyporales, dan Russulales. Berdasarkan substrat tempat tumbuh ditemukan sebanyak 57,14% jamur makro tumbuh di kayu lapuk dan 42,86% ditemukan di tanah atau serasah. Berdasarkan potensi pemanfaatannya teridentifikasi sebanyak empat spesies sebagai bahan pangan yaitu *Pleurotus ostreatus*, *Auricularia auricula*, *Ramaria formosa*, dan *Polyporus arcularius* dan sebanyak 11 spesies berpotensi sebagai bahan obat diantaranya *Calvatia craniiformis*, *Scleroderma citrinum*, *Lenzites betulina*, *Microporus flabelliformis*, *Coriolus versicolor*, *Microporus xanthopus*, dan *Albatrellus confluens*.

Kata kunci: Jamur makro, Cagar Alam Tangale, potensi, pangan, obat

ABSTRACT

Tangale Nature reserve is a conservation area located in Gorontalo that have the biodiversity typical of Wallacea bioregion including macroscopic fungi. The purpose of this study was to identify the fungal species diversity found in the Tangale Nature reserve as well as its potential use, considering that the information on species diversity of fungi in the Wallacea region is very limited. This research was conducted using the cruise method by identifying macroscopic fungi along the hiking trail of Tangale Nature Reserve. The macroscopic fungi were observed for its morphological characteristic include the colour, diameter, surface of the veil, the shape of the stem, the length and diameter of the stem, the lamella, including ring and pore, type of lamella and the type of volva. The research recorded the substrates and the location where the fungus was found. Data were analyzed descriptively qualitative. The results of the research identified 28 species of macroscopic fungi that included to the division Ascomycota and Basidiomycota. It belongs to 16 families and 8 orders are Pezizales, Agaricales, Auriculariales, Boletales, Cantharellales, Gomphales, Polyporales, dan Russulales. Based on place to grow as much as 57,14% were found growing on decaying wood and 42,86% found growing in the soil / litter. Based on the potential of use, it has identified four species of mushrooms potentially as edible mushroom are *Pleurotus ostreatus*, *Auricularia auricula*, *Ramaria formosa*, and *Polyporus arcularius*. 11 species of mushrooms potentially as medicinal mushroom are *Calvatia craniiformis*, *Scleroderma citrinum*, *Lenzites betulina*, *Microporus flabelliformis*, *Coriolus versicolor*, *Microporus xanthopus*, and *Albatrellus confluens*.

Keywords: Macrofungi, Tangale Nature Reserve, potential, food, medicine

INTRODUCTION

Mushrooms have been the objects of much curiosity and speculation, also as the most important components of the forest ecosystem. Their edibility, poisonous nature, psychotropic properties, mycorrhizal and parasitic associations with the forest trees make them economically important and interesting to study (Kumar *et al.*, 2013). Groups of mushroom (macrofungi) is a source of the biological resources of the Indonesian rainforest. Macrofungi have an important role in soil biogeochemical cycles, nutrient cycling and composting. Fungi is symbiont with plants that are beneficial or otherwise harming a

parasite for animals and plants. The fungus also contribute as a biocontrol agent and producer for other industries such as the pharmaceutical and food industries. Some species have been used by human as a food and medicine both traditional and modern.

In some parts of the world, the use of fungi have become increasingly widespread in line with the vigorous research on the importance of fungi for health and medicinal advantages. Utilization mushrooms as pharmaceuticals, food and cosmetics ingredients has been exist since long time ago. According to Roman history or King Pharaohs in the Kingdom of Egypt, fungi become food for king,

nobles and royal troops are believed to extend life, improve immunity (Jahan *et al.*, 2010). A history on Centuries of Chinese and the dynasty of Japan trust mushrooms as a healthy food ingredient with high nutritional value and medicinal function. The existence of wild macrofungi as a food ingredient has utilized widely around the world. Chinese take advantage of wild mushrooms as a food ingredient since hundreds of years BC (Aaronson, 2000).

Hendritomo (2010) explained that macrofungi convert biomass waste lignocellulose to foodstuffs, moreover it can produce ingredients (mycomedicine) that are beneficial to human health through environmental clean cultivation technique. In addition, edible mushrooms are source of polysaccharides and other bioactive substances such as antitumor, immunomodulator, and anticancer.

Tangale Nature Reserve is a conservation area which located in the Gorontalo Province and managed by the Natural Resource Agency of North Sulawesi. Tangale designated as a Nature reserve conservation area based on The Ministry of Forestry decree No. 431 / Kpts / II / 92 on May 5, 1999 with an area of 113 ha. Tangale forest area has endemic flora and fauna typical the Wallacea bioregion. Administratively The Tangale Nature Reserve is located in the Labanu village, District Tibawa, Gorontalo. Nowadays, the forest area of Tangale has been decreased due to land conversion and human activities.

The diversity of fungi, especially at the Wallacea bioregion yet widely known and well described, including the diversity of macrofungi in Tangale Nature Reserve, whereas some fungi can be used as a food and medicine because of the nutrients and bioactive compounds contained. The observations that has been done in the Nature Tangale found several species of fungus that grows on decaying wood, litter, and the haystack (Santoso *et al.*, 2013). Fungi usually grow well during the rainy season and would die after the dry season. Santoso *et al.* (2013) explains that Tangale Nature Reserve has a lowland forest ecosystem and the topography is hilly, at an altitude of 100–350 m above sea level. The rainfall duration in his region is 2390 mm a year, the wet seasons are 10 months and two months for dry season. The high rainfall and

low humidity are gives more possibilities to support the growth of the mushrooms.

MATERIALS AND METHODS

Study Area

Research was conducted at Tangale Nature Reserve (0–300 m asl). It is a series of research flora and fauna exploration by Manado Forestry Research Institute conducted in 2008–2009. The map of the research presented in (Figure 1).

Procedures

Data collection was conducted using cruise method (Rugayah and Pratiwi, 2004). Mushrooms that found along the tracking path of Tangale Nature Reserve was collected, observed and documented. Macroscopic observation conducted through determination of shape and color of the cap, the cap surface, type of cap, cap diameter, shaft shape, length and diameter of the stalk, present of the lamella or porous and ring, types of lamella, types of volva. The habitat of the mushroom also was recorded.

Data Analysis

Data were analyzed using descriptive qualitative. According to Sukmadinata (2009) qualitative analysis used to describe and analyze the phenomena, events, social activities, attitude, beliefs, perceptions, and people individually or in groups. The identification of macrofungi and their potential explained based on of some literatures following Boa (2004) and Carlile *et al.* (2004)

RESULTS AND DISCUSSION

The results showed that there were 28 species macrofungi of 16 families, *i.e.* Sarcosyphaceae, Rhiziniaceae, Pezizaceae, Agaricaceae, Strophariaceae, Thricolomataceae, Marasmiaceae, Pleurotaceae, Auriculariaceae, Sclerodermataceae, Chantarellaceae, Gomphaceae, Fomitopsidaceae, Polyporaceae, Russulaceae and Albatrellaceae. The sixteen families were belongs to eight orders, *i.e.* Pezizales, Agaricales, Auriculariales, Boletales, Cantharellales, Gomphales, Polyporales, and Russulales. These eight orders were included in class of Pezizomycetes and Agaricomycetes, that were

Source: Balai Penelitian Kehutanan Manado (2008)

Figure 1. Location of the research at Tangale Nature Reserve, Gorontalo (*Lokasi Penelitian CA. Tangale Propinsi Gorontalo*)

grouped in division of Ascomycota and Basidiomycota (Table 1).

Similar studies were conducted by Santosa *et al.* (2013) in Tangale Nature Reserve that find about 19 species of macroscopic fungi and belong to eight families. Based on divisions, the number of fungal species of the class Basidiomycota macrofungi is greater than Ascomycota, there are three Ascomycota species and 25 species of Basidiomycota.

Family of Polyporaceae has the largest number of members compared to other families as many as seven species. The species are *Microporus* sp., *Microporus flabelliformis*, *Microporus xanthopus*, *Polyporus arcularius*, *Lenzites betulina*, *Trametes gibbosa*, and *Coriolus versicolor*. The genus *Microporus* has the largest number consist of three species *i.e.* *Microporus* sp., *Microporus flabelliformis*, and *Microporus xanthopus*. According to Santosa *et al.* (2013), the Polyporaceae has the most number of species compare to another species, but it dominated by the genus of *Microporus* and *Polyporus*. Arora (1986) reported that Polyporaceae is one of some families that have variation in colors, shapes and sizes. The family of Polyporaceae have common characteristics of fan-shaped bracket with

himenium surface in the form of tiny holes called pores or it is modification. The fruiting body is woody, thick and coarse.

According to Dwidjoseputro (1978) Ascomycota division members are microscopic and only a small portion of macroscopic or have a fruiting body. The Agaricales dominated the number of families that consist of eight families and nine species. Hawksworth (2001) reported that species of Agaricales are dominated the ecosystem or cosmopolitan species. In the ecosystem, macrofungi of the Agaricales play role as decomposers that live on dead parts of plants especially Gymnosparmae and Angiosparmae, few live in humus. In addition most of Agaricales species are saprobic, *i.e.* mostly grown in soil, litter or humus and partly growing on dead plant parts Gymnosparmae or Angiosparmae.

Tangale Nature Reserve has environmental conditions including temperature and humidity that support the growth of macrofungi, as well as the availability of organic material supporting the growth of fungi of species Agaricales.

Several studies of fungal biodiversity in some areas in Indonesia showed that the dominance of the Agaricales. The macrofungi diversity study in Mount

Table 1. Macrofungi Diversity in Tangale Nature Reserve (*Keanekaragaman Makrofungi di CA. Tangale*)

Divisio (<i>Divisi</i>)	Class (<i>Kelas</i>)	Ordo (<i>Ordo</i>)	Family (<i>Famili</i>)	Species (<i>Spesies</i>)	Media (<i>Lokasi tumbuh</i>)	Potency (<i>Potensi</i>)
Asco- mycota	Pezizo- mycetes	Pezizales	Sarcosyphaceae	<i>Sarcoscypha occidentalis</i>	decaying wood	Unidentified
			Rhizinaceae	<i>Rhizina undulata</i>	litter/soil	Inedible ¹
			Pezizaceae	<i>Pachyella clypeata</i>	decaying wood	Unidentified
		Agaricales	Agaricaceae.	<i>Coprinellus disseminatus</i>	litter/soil	Medicine ²
				<i>Calvatia craniiformis</i>	litter/soil	Medicine ³
			Strophariaceae	<i>Pholiota squarrosa</i>	litter/soil	Edible ⁴
			Thricolomataceae	<i>Collybia confluens</i>	litter/soil	Medicine ⁵
				<i>Collybia cookei</i>	litter/soil	Unidentified
			Marasmiaceae	<i>Marasmius pulcherripes</i>	decaying wood	Unidentified
				<i>Marasmiellus sp.</i>	decaying wood	Unidentified
			Pleurotaceae	<i>Pleurotus ostreatus</i>	decaying wood	Edible ⁴
		Auriculariales	Auriculariaceae	<i>Auricularia auricula</i>	decaying wood	Edible ⁴
				<i>Tremellochaete sp.</i>	decaying wood	Unidentified
				<i>Auricularia sp.</i>	decaying wood	Unidentified
Basidi- omycota	Agarico- mycetes	Boletales	Sclerodermataceae	<i>Scleroderma citrinum</i>	litter/soil	Medicine ³
		Cantharellales	Chantarellaceae	<i>Chantarellus sp.</i>	litter/soil	Unidentified
		Gomphales	Gomphaceae	<i>Ramaria formosa</i>	litter/soil	Edible ⁴
			Fomitopsidaceae	<i>Ischnoderma resinosum</i>	decaying wood	Inedible ⁶
		Polyporales	Polyporaceae	<i>Microporus sp.</i>	decaying wood	Unidentified
				<i>Polyporus arcularius</i>	litter/soil	Medicine ⁷
				<i>Lenzites betulina</i>	decaying wood	Medicine ³
				<i>Microporus flabelliformis</i>	decaying wood	Medicine ⁸
				<i>Trametes gibbosa</i>	decaying wood	Inedible ⁹
				<i>Coriolus versicolor</i>	decaying wood	Medicine ¹⁰
				<i>Microporus xanthopus</i>	decaying wood	Medicine ³
		Russulales	Russulaceae	<i>Russula sanguinea</i>	litter/soil	Medicine ⁷
				<i>Russula sp.</i>	litter/soil	Unidentified
			Albatrellaceae	<i>Albatrellus confluens</i>	decaying wood	Medicine ³

Remarks (*Keterangan*) ¹Jonnalagadda *et al.* (2006); ²Novakovic *et al.* (2016); ³Boa (2004); ⁴Dutta and Acharya (2014); ⁵Simon *et al.*, (1995); ⁶Noor and Saridan (2013); ⁷Dai *et al.*, (2009); ⁸Prasetyaningsih dan Rahardjo (2014); ⁹Ao *et al.* (2016); ¹⁰Eliza *et al.* (2012);

Merapi Central Java showed that 129 species of macrofungi in south slopes, 51 species included in Agaricales, while on the northern slope are 37 species and 19 are Agaricales (Prasetyaningsih and Rahardjo, 2015). Suharno *et al.* (2014) reported that in the district of Manokwari Regency Warmare West Papua, the Agaricales and Russulales are the largest species (about 80% of the total species of fungi).

According to Tapwal *et al.* (2013) mushrooms can grow in soil or degrading plant residues as saprophytes, wood decaying and many live in symbiotic association with the roots of higher plant species. Macroscopic fungi species founded in Tangale Nature Reserve was dominated living in wood is 57.14%. This percentage higher than the macroscopic fungi that live in soil or litter (42.86%) (Figure 2). The high diversity of species that grow on rotting wood because of the occurrence of good their growth. The study of

Tampubolon *et al.* (2013) at Hutan Pendidikan University of North Sumatra in the Karo district of North Sumatra showed a similar case, where as much as 62.22% of 28 types of macroscopic found living on decayed wood, but only three species of macroscopic fungi (6.67%) living in rotten wood or litter/soil. Asnah (2010) explained that the macroscopic fungi can be found in a variety of habitats, from the Arctic to the tropics, but some of them can also indicate a specific habitat. Generally, macroscopic fungi can grow on rotting wood, litter/soil, manure and also on decaying fungi. Kurniatin (2007) suggested that litters in the humid forest and lack of sunlight that reach the forest floor, will provide nutrients for the life of mushrooms.

Our result showed that wild macrofungi growing in Tangale Nature Reserve have the potential to be commercialized because of its edibility. The 14,3% (four species) are edible fungi *i.e.* *Pleurotus ostreatus*, *Auricularia auricula*,

Figure (Gambar) 2. Some of the macrofungi species were found in Tangale Nature Reserve, (*Beberapa jenis makrofungi yang dijumpai di Cagar Alam Tangale*) (A). *Polyporus arcularius*; (B). *Ramaria formosa*; (C). *Calvatia craniiformis*; (D). *Pachyella clypeata*; (E). *Trametes gibbosa*; (F). *Coriolus versicolor*; (G). *Microporus xanthopus*; (H). *Coprinellus disseminatus*; (I). *Russula* sp.; (J). *Marasmius pulcherripes*; (K). *Sarcoscypha occidentalis*; (L). *Auricularia* sp.

Figure (Gambar) 3. Percentage of potential use of the macrofungi in Tangale Nature Reserve (*Presentase peluang potensi pemanfaatan makrofungi di CA. Tangale*)

Ramaria formosa, and *Polyporus arcularius*. *Auricularia auricula* or tree ear has long been known as a food ingredient. The nutrient content in cultivated *Auricularia auricula* are ash 3.6%, 12.5% protein, 1.7% fat and 66.1% carbohydrates (Kadnikova *et al.*, 2015). Macrofungi has the active compounds as a source of medicine and nutraceutical (supplements, minerals and vitamins). Especially on some types of basidiomycetes containing bioactive that can be extracted and has nutritional and medical content that can be used to prevent and treat of diseases. It caused by active compounds in mushrooms such as anti-cancer, anti-cholesterol, anti-microbial (bacteria) and viruses (Prasetyaningsih and Rahardjo, 2015).

A total of 11 species or 39,3% based on the literature has potential as medicine *i.e.* *Coprinellus disseminatus*, *Calvatia craniiformis*, *Collybia confluens*, *Scleroderma citrinum*, *Lenzites betulina*, *Polyporus arcularius*, *Microporus flabelliformis*, *Coriolus versicolor*, *Microporus xanthopus*, *Russula sanguinea*, and *Albatrellus confluens*. The results showed that *Microporus flabelliformis* contains active anti-bacterial. The experimental results of some macrofungi extracts against bacteria *Xanthomonas oryzae* pv. *Oryzae*, *Ralstonia solanacearum* and *Pectobacterium carotovorum* showed that Ganoderma extract and *Microporus flabelliformis* most effective in suppressing the growth of bacteria.

Pleurotus ostreatus besides potential as a food, it also contains active compounds identified as pleurin (Prasetyaningsih and Rahardjo, 2015). Some species of macrofungi also has the potential as growth stimulator for plants such as *Scleroderma citrinum* species known in symbiosis with pines, the utilization *Scleroderma citrinum* powder in small doses is very beneficial for the growth of Tusam seedlings (Darwo and Sugiarti, 2008). *Sarcoscypha* species are well known for several applications including culinary use, and ability to produce interesting enzymes with potential uses in biotechnological processes like bioremediation, biodegradation biopulping and detoxification of recalcitrant substances since they have some bioactive compounds for example *Sarcoscypha coccinea* is known to be used as a medicinal

(Tibuhwa, 2011). A total of three species or 10,7% are known as inedible macrofungi which is cannot be eaten those are *Rhizina undulata*, *Ischnoderma resinosum*, and *Trametes gibbosa*. Chew (2008) explains that some types of fungi which the color is very striking, there are not bitten by other organisms and cause a foul odor generally contains sulfide compounds that cause stench like rotten egg smell (H₂S) or the smell of ammonia (NH₃) or cyanide compounds. A total of seven species or 25% still can not be identified its benefits (unidentified) due to limitations in the identification of the type can only be made up to the stage genus yet on the species. These species include *Marasmiellus* sp., *Tremellochaete* sp., *Auricularia* sp., *Chantarellus* sp., *Microporus* sp., *Russula* sp. and species of *Marasmius pulcherripes* which is still very little information.

CONCLUSION

This research showed that in Tangale Nature Reserve we can found at least 28 species of macrofungi covering Ascomycota and Basidiomycota orders. Ascomycota division consists one order there is Pezizales, three families and three species. Basidiomycota consists of seven orders namely Agaricales, Auriculariales, Boletales, Cantharellales, Gomphales, Polyporales, and Russulales, 14 families and 25 species. Identification of potential utilization from 28 macrofungi species showed that five species of macrofungi are edible as food *i.e.* *Coprinellus disseminatus*, *Pleurotus ostreatus*, *Auricularia auricula*, *Ramaria formosa*, and *Polyporus arcularius* and seven species of macrofungi have opportunity to be utilized as a medicine materials *i.e.* *Calvatia craniiformis*, *Scleroderma citrinum*, *Lenzites betulina*, *Microporus flabelliformis*, *Coriolus versicolor*, *Microporus xanthopus*, dan *Albatrellus confluens*.

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Pedoman Penulisan Naskah Berita Biologi

Berita Biologi adalah jurnal yang menerbitkan artikel kemajuan penelitian di bidang biologi dan ilmu-ilmu terkait di Indonesia. Berita Biologi memuat karya tulis ilmiah asli berupa makalah hasil penelitian, komunikasi pendek dan tinjauan kembali yang belum pernah diterbitkan atau tidak sedang dikirim ke media lain. Masalah yang diliput harus menampilkan aspek atau informasi baru.

Tipe naskah

1. Makalah lengkap hasil penelitian (*original paper*)

Naskah merupakan hasil penelitian sendiri yang mengangkat topik yang *up to date*. Tidak lebih dari 15 halaman termasuk tabel dan gambar. Pencantuman lampiran seperlunya, namun redaksi berhak mengurangi atau meniadakan lampiran.

2. Komunikasi pendek (*short communication*)

Komunikasi pendek merupakan makalah hasil penelitian yang ingin dipublikasikan secara cepat karena hasil termuan yang menarik, spesifik dan baru, agar dapat segera diketahui oleh umum. Artikel yang ditulis tidak lebih dari 10 halaman. Hasil dan pembahasan boleh digabung.

3. Tinjauan kembali (*review*)

Tinjauan kembali merupakan rangkuman tinjauan ilmiah yang sistematis-kritis secara ringkas namun mendalam terhadap topik penelitian tertentu. Hal yang ditinjau meliputi segala sesuatu yang relevan terhadap topik tinjauan yang memberikan gambaran '*state of the art*', meliputi temuan awal, kemajuan hingga issue terkini, termasuk perdebatan dan kesenjangan yang ada dalam topik yang dibahas. Tinjauan ulang ini harus merangkum minimal 30 artikel.

Struktur naskah

1. Bahasa

Bahasa yang digunakan adalah Bahasa Indonesia atau Inggris yang baik dan benar.

2. Judul

Judul diberikan dalam bahasa Indonesia dan Inggris. Judul ditulis dalam huruf tegak kecuali untuk nama ilmiah yang menggunakan bahasa latin. Judul harus singkat, jelas dan mencerminkan isi naskah dengan diikuti oleh nama serta alamat surat menyurat penulis dan alamat email. Nama penulis untuk korespondensi diberi tanda amplop cetak atas (*superscript*).

3. Abstrak

Abstrak dibuat dalam dua bahasa, bahasa Indonesia dan Inggris. Abstrak memuat secara singkat tentang latar belakang, tujuan, metode, hasil yang signifikan, kesimpulan dan implikasi hasil penelitian. Abstrak berisi maksimum 200 kata, spasi tunggal. Di bawah abstrak dicantumkan kata kunci yang terdiri atas maksimum enam kata, dimana kata pertama adalah yang terpenting. Abstrak dalam Bahasa Inggris merupakan terjemahan dari Bahasa Indonesia. Editor berhak untuk mengedit abstrak demi alasan kejelasan isi abstrak.

4. Pendahuluan

Pendahuluan berisi latar belakang, permasalahan dan tujuan penelitian. Perlu disebutkan juga studi terdahulu yang pernah dilakukan terkait dengan penelitian yang dilakukan.

5. Bahan dan cara kerja

Bahan dan cara kerja berisi informasi mengenai metode yang digunakan dalam penelitian. Pada bagian ini boleh dibuat sub-judul yang sesuai dengan tahapan penelitian. Metoda harus dipaparkan dengan jelas sesuai dengan standar topik penelitian dan dapat diulang oleh peneliti lain. Apabila metoda yang digunakan adalah metoda yang sudah baku cukup ditulis sitasinya dan apabila ada modifikasi maka harus dituliskan dengan jelas bagian mana dan hal apa yang dimodifikasi.

6. Hasil

Hasil memuat data ataupun informasi utama yang diperoleh berdasarkan metoda yang digunakan. Apabila ingin mengacu pada suatu tabel/grafik/diagram atau gambar, maka hasil yang terdapat pada bagian tersebut dapat diuraikan dengan jelas dengan tidak menggunakan kalimat 'Lihat Tabel 1'. Apabila menggunakan nilai rata-rata maka harus menyertakan pula standar deviasinya.

7. Pembahasan

Pembahasan bukan merupakan pengulangan dari hasil. Pembahasan mengungkap alasan didapatkannya hasil dan arti atau makna dari hasil yang didapat tersebut. Bila memungkinkan, hasil penelitian ini dapat dibandingkan dengan studi terdahulu.

8. Kesimpulan

Kesimpulan berisi informasi yang menyimpulkan hasil penelitian, sesuai dengan tujuan penelitian, implikasi dari hasil penelitian dan penelitian berikutnya yang bisa dilakukan.

9. Ucapan terima kasih

Bagian ini berisi ucapan terima kasih kepada suatu instansi jika penelitian ini didanai atau didukung oleh instansi tersebut, ataupun kepada pihak yang membantu langsung penelitian atau penulisan artikel ini.

10. Daftar pustaka

Tidak diperkenankan untuk mensitasi artikel yang tidak melalui proses *peer review*. Apabila harus menyitir dari "laporan" atau "komunikasi personal" dituliskan '*unpublished*' dan tidak perlu ditampilkan di daftar pustaka. Daftar pustaka harus berisi informasi yang *up to date* yang sebagian besar berasal dari *original papers* dan penulisan terbitan berkala ilmiah (nama jurnal) tidak disingkat.

Format naskah

1. Naskah diketik dengan menggunakan program Microsoft Word, huruf New Times Roman ukuran 12, spasi ganda kecuali Abstrak spasi tunggal. Batas kiri-kanan atas-bawah masing-masing 2,5 cm. Maksimum isi naskah 15 halaman termasuk ilustrasi dan tabel.
2. Penulisan bilangan pecahan dengan koma mengikuti bahasa yang ditulis menggunakan dua angka desimal di belakang koma. Apabila menggunakan Bahasa Indonesia, angka desimal ditulis dengan menggunakan koma (,) dan ditulis dengan menggunakan titik (.) bila menggunakan bahasa Inggris. Contoh: Panjang buku adalah 2,5 cm. Length of the book is 2.5 cm. Penulisan angka 1-9 ditulis dalam kata kecuali bila bilangan satuan ukur, sedangkan angka 10 dan seterusnya ditulis dengan angka. Contoh lima orang siswa, panjang buku 5 cm.
3. Penulisan satuan mengikuti aturan *international system of units*.
4. Nama takson dan kategori taksonomi ditulis dengan merujuk kepada aturan standar yang diakui. Untuk tumbuhan menggunakan *International Code of Botanical Nomenclature* (ICBN), untuk hewan menggunakan *International Code of Zoological Nomenclature* (ICZN), untuk jamur *International Code of Nomenclature for Algae, Fungi and Plant* (ICFAP), *International Code of Nomenclature of Bacteria* (ICNB), dan untuk organisme yang lain merujuk pada kesepakatan Internasional. Penulisan nama takson lengkap dengan nama author hanya dilakukan pada bagian deskripsi takson, misalnya pada naskah taksonomi. Penulisan nama takson untuk bidang lainnya tidak perlu menggunakan nama author.
5. Tata nama di bidang genetika dan kimia merujuk kepada aturan baku terbaru yang berlaku.
6. Untuk range angka menggunakan en dash (–), contohnya pp.1565–1569, jumlah anakan berkisar 7–8 ekor. Untuk penggabungan kata menggunakan hyphen (-), contohnya: masing-masing.
7. Ilustrasi dapat berupa foto (hitam putih atau berwarna) atau gambar tangan (*line drawing*).
8. Tabel
Tabel diberi judul yang singkat dan jelas, spasi tunggal dalam bahasa Indonesia dan Inggris, sehingga Tabel dapat berdiri sendiri. Tabel diberi nomor urut sesuai dengan keterangan dalam teks. Keterangan Tabel diletakkan di bawah Tabel. Tabel tidak dibuat tertutup dengan garis vertikal, hanya menggunakan garis horisontal yang memisahkan judul dan batas bawah.

8. **Gambar**
Gambar bisa berupa foto, grafik, diagram dan peta. Judul gambar ditulis secara singkat dan jelas, spasi tunggal. Keterangan yang menyertai gambar harus dapat berdiri sendiri, ditulis dalam bahasa Indonesia dan Inggris. Gambar dikirim dalam bentuk .jpeg dengan resolusi minimal 300 dpi, untuk *line drawing* minimal 600dpi.
9. **Daftar Pustaka**
Sitasi dalam naskah adalah nama penulis dan tahun. Bila penulis lebih dari satu menggunakan kata 'dan' atau *et al.* Contoh: (Kramer, 1983), (Hamzah dan Yusuf, 1995), (Premachandra *et al.*, 1992). Bila naskah ditulis dalam bahasa Inggris yang menggunakan sitasi 2 orang penulis maka digunakan kata 'and'. Contoh: (Hamzah and Yusuf, 1995). Jika sitasi beruntun maka dimulai dari tahun yang paling tua, jika tahun sama maka dari nama penulis sesuai urutan abjad. Contoh: (Anderson, 2000; Agusta *et al.*, 2005; Danar, 2005). Penulisan daftar pustaka, sebagai berikut:
 - a. **Jurnal**
Nama jurnal ditulis lengkap.
Agusta, A., Maehara, S., Ohashi, K., Simanjuntak, P. and Shibuya, H., 2005. Stereoselective oxidation at C-4 of flavans by the endophytic fungus *Diaporthe* sp. isolated from a tea plant. *Chemical and Pharmaceutical Bulletin*, 53(12), pp.1565–1569.
 - b. **Buku**
Anderson, R.C. 2000. *Nematode Parasites of Vertebrates, Their Development and Transmission*. 2nd ed. CABI Publishing, New York. pp. 650.
 - c. **Prosiding atau hasil Simposium/Seminar/Lokakarya.**
Kurata, H., El-Samad, H., Yi, T.M., Khammash, M. and Doyle, J., 2001. Feedback Regulation of the Heat Shock Response in *Eschericia coli*. *Proceedings of the 40th IEEE Conference on Decision and Control*. Orlando, USA pp. 837–842.
 - d. **Makalah sebagai bagian dari buku**
Sausan, D., 2014. Keanekaragaman Jamur di Hutan Kabungolor, Tau Lumbis Kabupaten Nunukan, Kalimantan Utara. Dalam: Irham, M. & Dewi, K. eds. *Keanekaragaman Hayati di Beranda Negeri*. pp. 47–58. PT. Eaststar Adhi Citra. Jakarta.
 - e. **Thesis, skripsi dan disertasi**
Sundari, S., 2012. Soil Respiration and Dissolved Organic Carbon Efflux in Tropical Peatlands. *Dissertation*. Graduate School of Agriculture, Hokkaido University, Sapporo. Japan.
 - f. **Artikel online.**
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Himman, L.M., 2002. A Moral Change: Business Ethics After Enron. San Diego University Publication. <http://ethics.sandiego.edu/LMH/oped/Enron/index.asp>. (accessed 27 Januari 2008) bila naskah ditulis dalam bahasa inggris atau (diakses 27 Januari 2008) bila naskah ditulis dalam bahasa indonesia

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Setiap penulis yang mengajukan naskahnya ke redaksi Berita Biologi akan diminta untuk menandatangani lembar persetujuan yang berisi hak alih terbit naskah termasuk hak untuk memperbanyak artikel dalam berbagai bentuk kepada penerbit Berita Biologi. Sedangkan penulis tetap berhak untuk menyebarkan edisi cetak dan elektronik untuk kepentingan penelitian dan pendidikan. Formulir itu juga berisi pernyataan keaslian naskah yang menyebutkan bahwa naskah adalah hasil penelitian asli, belum pernah dan tidak sedang diterbitkan di tempat lain serta bebas dari konflik kepentingan.

Penelitian yang melibatkan hewan

Setiap naskah yang penelitiannya melibatkan hewan (terutama mamalia) sebagai obyek percobaan/penelitian, wajib menyertakan 'ethical clearance approval' terkait animal *welfare* yang dikeluarkan oleh badan atau pihak berwenang.

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