INDONESIAN ARCHAEOBOTANIC RESEARCH DEVELOPMENT

Perkembangan Penelitian Arkeobotani di Indonesia

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Abstract. *The application of archaeobotany has been increasing for the last ten years in Indonesia, especially for studying the prehistoric human occupation. Indonesia has incredible biodiversity in flora, and the application of archaeobotanical methods and techniques is essential for understanding people-plant relationships in the past. It is also able to support and complement archaeological results and interpretations developed from analyses of other types of material culture. This paper examines archaeobotanical research in Indonesia through available published literature. The result demonstrates archaeobotanical analyses strengthen and enhance the interpretations of archaeological data and highlight the biases in the application towards prehistoric sites. Our research suggests that more recent archaeological sites have great potential for the application of archaeobotany. This approach needs to be introduced in the early stages of all project planning and research so that suitable recovery methods can be utilized, and adequate time and finances for analyses are factored in. The availability of facilities, infrastructure, and human resources to analyze archaeobotanical data will bring more opportunities for analyses in this field.*

Keywords: *Archaeobotany, Microbotanical Remains, Pollen, Phytolith, Starch, Macrobotanical Remains*

Abstrak. Selama sepuluh tahun terakhir, penelitian arkeobotani tengah berkembang di Indonesia, khususnya bidang prasejarah. Penelitian arkeobotani di Indonesia merupakan hal yang penting untuk memahami hubungan antara manusia purba dengan tumbuhan, mengingat Indonesia merupakan negara dengan biodiversitas tinggi pada aspek flora. Selain itu, penelitian arkeobotani juga menghasilkan data pendukung untuk analisa material situs arkeologi. Penelitian ini membahas perkembangan penelitian arkeobotani di Indonesia melalui metode kajian pustaka. Hasil dari penelitian ini menunjukkan bahwa analisis arkeobotani berguna untuk memperkuat dan meningkatkan interpretasi data arkeologi serta menyoroti bias dalam penerapannya pada situs prasejarah. Dijelaskan bahwa situs arkeologi yang lebih baru memiliki potensi besar untuk penerapan arkeobotani. Pendekatan arkeobotani perlu diperkenalkan pada tahap awal perencanaan dan penelitian sehingga metode pemulihan yang sesuai dapat ditentukan, serta pertimbangan dalam hal waktu dan keuangan juga dapat diperhitungkan. Kelengkapan sarana, prasarana dan sumber daya manusia dalam menganalisis data arkeobotani akan membawa lebih banyak peluang dalam bidang ini.

Kata kunci: Arkeobotani, Tinggalan Mikrobotani, Polen, Fitolit, Pati, Tinggalan Makrobotani

1. Introduction

Known as an agrarian country, Indonesia can also be considered a country that is close to the agricultural field which has been studied intensively through archaeology (Sémah et al., 2004) research in Ambarawa, Central Java by analyzing pollen. Up to the year 2000, archaeological researchers in Indonesia usually used pollen data. One of the pioneers, Vita, wrote an article in 1997 titled "Plant Identification based on Pollen Characteristics: A Basis for Sediment Pollen Identification in Archaeology". However, the usage of pollen as microbotanical data has its limitations due to the nature of pollen which is easily spread by the wind, so it may not originate from the site in situ, so pollen data is useful for describing the macro environment (Renfrew & Bahn, 2016). The study of botanical remains recovered from stratified archaeological sites).

The data used in archaeobotanical research are divided into two types: microbotanical remains and macrobotanical remains. Examples of microbotanical remains are pollen, phytolith, and starch (Piperno, 2006). For macro botany, there are wood charcoal, seeds, stems, and roots as well as other plant parts that are visible to the naked eye (Pearsall, 2010). Nevertheless, the form identification and analysis method of flora is not only based on organic material but also on floral decorations such as reliefs or statues and rock art depictions. Although those findings are largely subjective, botanical principles are used for identification (Siswanto, 2000).

One of the difficulties in writing an archaeobotanical paper is the access to references. In Indonesia, the study of archaeobotany is not only rare, but it has also worsened by the fact that access to archaeobotany references is hard to obtain.

Identification of plant remains in archaeobotanical research usually delivers taxonomic information at the level of family, genus, and/or species, where possible (Fuller, 2020). A clear description of reconstructing vegetation from certain sites is gained from that information (Anshari et al., 2001). If a species of plant is found to be foreign in that site, it can indicate the spread or introduction of that plant. However, local plants can also be an indicator of its dissemination.

Reconstructing the paleoenvironment of an archaeological site, the study of the human utilization of economically important plant species, diet, and subsistence strategies, and, in the case of introduced species, how these specific plant species adapted to new environments (Patridina, 2018). This is in line with the goals of archeology, namely reconstructing prehistory based on the remains of past societies, reconstructing the behavior and way of life of people who supported past cultures, and presenting an explanation of the process of cultural development in the past. The nature of plant exploitation, diet, and plant consumption processes are affected over time by seasonal factors, environmental changes, technological developments, humans as cultural actors, culture itself, and economic dynamics (Lentfer, 2009).

In Indonesia, archaeobotanical approaches have been known for a long time, but their implementation and interest are still minimal. The lack of and/or access to reference collections further constrains the application. Ecofact findings at Indonesian archaeological sites when accompanied by a comprehensive understanding of the state of the environment around the site (past and present) will produce a clear picture of the process of interaction and exploitation of plants by humans as cultural supporters (Alifah et al., 2022).

Another archaeobotanical data that is rarely studied by Indonesian archaeobotanical researchers is Non-Pollen Palynomorphs (NPP). The use of NPP, especially for fossils from coprophilic mushroom ascospores in archaeobotanical research can provide information about the existence of fauna in the

past, especially the types of wild or livestock herbivores (Setyaningsih et al., 2019). Non-pollen Palynomorphs are microscopic objects with organic walls whose sizes are in the range of 10–250 μm and can be found around pollen during the pollen-counting stage in the laboratory (Shumilovskikh & van Geel, 2020.

This research aims to examine the development of archaeobotanical research in Indonesia and provides prospects on how archaeobotanical research can help to achieve archaeological goals, such as environmental reconstruction. The use of an archaeobotanical approach will also strengthen research results and provide narratives around people-plant relationships that are often neglected.

The beginning of semi-sedentary human life requires them to develop the ability to raise animals and plant tubers around their living area (Hidayah, 2014). Archaeobotanical remains produce primary data for the reconstruction of vegetation, land use practices, diets, and trade in exotic plants, and can also provide information about many social aspects of society such as consumption, labor arrangements, and differences in status (Miller, 1995).

Technological developments have also influenced the analytical methods of archaeological research, an example of which is the emergence of and further development of several scientific approaches. Recent advances demonstrate archaeobotanical research data can be obtained from artifact residues (Alifah, 2017; Patridina, 2018), in sediments around archaeological sites (Anggraeni, 2012), or from ecofacts such as teeth. (Tromp & Dudgeon, 2015). Phytoliths found on the surfaces of artifacts can determine what types of plants were used, and starch data found on tooth ecofacts can show the types of plants that were used for diets because starch contains polymeric carbohydrates (Alifah, 2017). Also, pollen data can be used for climate fluctuations or land clearing as well as reconstruction of past vegetation (Renfrew & Bahn, 2016).

Preserved macroscopic plant remains are usually found in conditions that favor their preservation such as in a charred or carbonized, mineralized, waterlogged, or dry state (Lempiäinen-Avci, 2019). Macrobotanical remains can also be preserved if a mineralization process occurs, but this is relatively rare because this process requires an adequate place where minerals can replace plant cell structures (Day, 2013).

In general, macroscopic data are processed by dry sieving, wet sieving, and, depending on a range of site-specific factors, flotation although flotation has been shown to have mixed results, especially in tropical environments. As archaeological data, plants are classified as easily damaged because they decompose, especially with Indonesia's tropical climate which can speed up the process of decoding archaeological data derived from plants (Perdana Y, 2022).

2. Methods

This research was conducted by using the literature review. The types of literature are mostly in the form of scientific journal articles whose final assignments were conducted in Indonesia, and a small number of others are libraries that generally explain archaeobotany itself. The literature was published from 2009 to 2022 related to archeobotany carried out in Indonesia. This research excluded works by foreign researchers and focused on research by Indonesian researchers.

Data from the library sources were obtained through various online and offline channels. These data were then used as a guide to trace the development of archaeobotanical research in Indonesia. The literature review was chosen because by looking at various archaeobotanical research in Indonesia and the year the literature was published, a conclusion can be drawn to explain the development of archaeobotanical research in Indonesia.

3. Results and Discussion

3.1 Result

From 2013 to 2022 there were at least 10 undergraduate theses, 2 theses, and 2 dissertations that used the archaeobotanical approaches, (phytolith, starch, and pollen) at Gadjah Mada University. Apart from that, there are at least four research publications conducted by Indonesian archaeologists, several of which used pollen and phytolith data (Alifah & Mahirta, 2021; Hidayah et al., 2021; Matori, 2013; Setyaningsih et al., 2019). In 2021 two publications give more detailed explanations of microbotanical analysis and its benefits (Alifah, 2017) and writing about the development of phytolith analysis (Pratama, 2020a). There are also two further publications on microbotanical analyses by Indonesian researchers.

Table 1 shows archaeobotanical research in Indonesia which generally focuses on the plants used in the past, the reconstruction of past vegetation, and finding out the benefits of an artifact using residue analysis.

The following is a table of publications research using the archaeobotanical approach in Indonesia.

Table 1. Scientific publications 2009-2022 by Indonesian researchers using archaeobotanical data from archaeological sites in Indonesia.
Source: the author is processed from various sources

No.	Article Title	Site location	Data Type/article focus	Source
1.	*Rekonstruksi Lingkungan pada Masa Pleistosen Tengah di Situs Arkeologi/ Paleontologi Mata Menge , Flores, Indonesia.* Environmental reconstruction of The Middle Pleistocene Archaeological/ Palaeontological Site Mata Menge, Flores, Indonesia.	Mata Menge, Flores	Pollen from sediment/ Environmental reconstruction	(van den Bergh *et al*., 2009
2.	*Analisis Fitolit: Pada Residu Artefak Tulang Situs Song Blendrong.* Phytolith Analysis: Residues of Song Blendrong Site Bone Artifacts.	Song Blendrong Site, Java	Phytolith from bone tools residues/Bone tools used to exploit edible plant species	(Marniati & Fajari, 2009).

3.	Human-Environment Interactions in Mountain Rainforests: Archaeobotanical Evidence from Central Sulawesi, Indonesia. *Interaksi Manusia-Lingkungan di Hutan Hujan Pegunungan: Bukti Archaeobotanical dari Sulawesi Tengah, Indonesia.*	Besoa Valley, Sulawesi	Pollen, macro plant remains, and micro-charcoal from the core	(Kirleis et al., 2011)
4.	*Rekonstruksi Hutan Purba di Kawasan Karst Gunungsewu dalam Periode Sejarah Manusia*. Ancient Forest Reconstruction at Gunungsewu Karst in The Period of Humans History.	Gunung Sewu sediment/	Pollen from The discovery of three types of flora originating from prehistoric times to the present, namely the lower montane forest type, tropical forest type, and monsoon forest type.	(Faida et al.,., 2011).
5.	*Hipotesis Migrasi Austronesia Berdasarkan Pada Hunian Prasejarah di Sungai Karama, Mamuju, Sulawesi Barat.* The Austronesian Migration Hypothesis as Seen from Prehistoric Settlement on the Karama River, Mamuju, West Sulawesi.	Karama Valey, Sulawesi	Phytolith from sediment/ Seeing the possibility of early domestication of grains based on phytolith analysis.	(Anggraeni, 2012).

6.	*Pemanfaatan Tumbuhan di Situs Song Towo: Berdasarkan Hasil Analisis Residu Fitolit pada Artefak Batu dan Tulang.* Plant Exploitation at Song Towo Site: Based On Phytolith Analisis from Stone and Bone Artifact.	Song Towo Site artifact	Phytolith from residues and bone tools/ Traces of the use of plants by humans supporting the Song Towo Site, Ponjong can be seen from the remains of phytolith in stone and bone artifacts.	(Octina, 2013)
7.	*Lingkungan Vegetasi Dulu dan Kini di Situs Kobatuwa II, Nusa Tenggara Timur.* Past and Present Vegetation of Kobatuwa Site II, East Nusa Tenggara.	Koba Tuwa Site /	Pollen from sediment Vegetation environmental conditions prehistoric times and now at the Kobatuwa II site, NTT.	(Matori, 2013).
8.	*Kajian Lingkungan Purba Mikro Pada Situs Gua Kidang, Desa Tinapan, Kecamatan Todanan, Kabupaten Blora (Analisis Fitolit).* *S*tudy of Micro Ancient Environment at Gua Kidang Site, Tinapan Village, Todanan Subdistrict, Blora Regency (Phytolith Analysis).	Gua Kidang Site	Phytolith from sediment/ Reconstruction of the environmental conditions of Kidang Cave as a dwelling cave through phytolith analysis.	(Idrus, 2015).

9.	Unraveling The Past 1000 Years of History of Human-Climate-Landscape Interaction At The Lindu Plain, Sulawesi, Indonesia. *Menguak Sejarah Interaksi antara Manusia-Iklim-Lanskap pada 1000 Tahn yang Lalu di Dataran Lindu, Sulawesi, Indonesia*	Lindu Plain, Sulawesi	Palynological analysis, micro-charcoal analysis, macro-charcoal analysis, and algae analysis / Analysis of palynology, charcoal, and algae from Lake Lindu sediments shows that for 1000 years the Lindu Plain has been influenced by human activities.	(Biagioni *et al*., 2016)
10.	*Variasi Tumbuhan Masa Prasejarah Kajian Berdasarkan Fitolit pada Sedimen Song Gilap, Wonogiri.* Variety of Prehistoric Plant Based On Phytolith Analysis of Song Gilap Sediment, Wonogiri.	Song Gilap Site sediment/	Phytolith from At the Song Gilap Site, bilobate, elongated, saddled phytoliths have been found, and several unidentified forms. It is estimated that the Soursop plant is a natural plant in Song Gilap.	(Elvida, 2016).
11.	*Paleovegetasi Berdasarkan pada Kajian Polen dan Fitolit di Gua Harimau dan Perjalanan Panjang Peradaban OKU.* Paleovegetation Based on Palinology Study and Phytolith Analyses in Harimau Cave and The Long Journey of OKU Civilization.	Harimau Cave Site	Pollen and phytolith from sediment/View of past vegetation at the Tiger Cave Site, based on pollen and phytolith analysis.	(Vita, Sayekti and Octina, 2016)

12.	*Mikrofosil Tumbuhan (Phytoliths) Situs Wineki Dan Padang Hadoa, Di Kawasan Lembah Besoa, Sulawesi Tengah.* Plants Microfossil in Wineki Site and Padang Hadoa, in Besoa Valley, Central Sulawesi.	Wineki and Padang Hadoa Site.	Phytolith from sediment/ The condition of the vegetation environment at the Wineki Siteand Padang Hadoa is seen from the analysis of the phytolith.	(Octina, 2017).
13.	*Pemanfaatan Analisis Phytolith dan Starch dalam Studi Arkeologi Lingkungan.* The Utilization of Phytolith Analysis in Enviromental Archaeology.	Literature Studies.	Microbotany research literature study with main data phytoliths and starch/ The use of microscopic analysis of plant remains in the form of phytolith and starch for environmental studies.	(Alifah, 2017).
14.	*Pemanfaatan Kerang dan Tumbuhan di Situs Gua Gede Nusa Penida, Bali.* The Utilization of Clams and Plants in Gede Cave Site, Nusa Penida, Bali.	Gua Gede Site.	Phytolith obtained by extracting residue on pottery shards, bone, and shell artifacts sediment samples/ along with analysis of The discovery of shell ecofacts and phytoliths at the Gua Gede site indicates the use of natural resources around the site since 8,800±50 BP.	(Hidayah, 2017).

15.	*Sumber Daya Tumbuhan dan Pemanfaatannya di Situs Gua Makpan, Alor, Nusa Tenggara Timur (40.000-2.500 BP).* Plant Resources and Its Utilization in Makpan Cave Site, Alor, East Nusa Tenggara (40.000-2.500 BP).	Gua Makpan Site.	Phytoliths and starch are found in loose dirt, sediment, and residues/ Reveal how Makpan Cave inhabitants use plant resources. This study aims to reconstruct the ecology of Makpan Cave and the utilization of plants by Makpan Cave residents.	(Patridina, 2018).
16.	*Bukti Paleoekologi Pertama dari Peternakan Kerbau dan Pertanian Beras di Taman Nasional Kerinci Seblat, Sumatra, Indonesia First* Palaeoecological Evidence of Buffalo Husbandry and Rice Cultivation in The Kerinci Seblat National Park in Sumatra, Indonesia.	Seblat National Park.	Palynology analysis, macro-charcoal analysis, analysis of non-pollen palynomorphs, and analysis of numerical data /The origins of rice processing and buffalo farming in Sumatra.	(Setyaningsih et al., 2019).

17.	*Konsumsi Sirih Pinang dan Patologi Gigi pada Masyarakat Prasejarah Lewoleba dan Liang Bua, di Nusa Tenggara, Indonesia.* The Areca Nut Consumption and Dental Pathology of Prehistoric People of Lewoleba and Liang Bua, Nusa Tenggara, Indonesia.	Liang Bua Site. prehistoric	Teeth from humans remain from Lewoleba and human skeletal remains from Liang Bua/ The causal relationship between the consumption of betel nut and the emergence of dental pathology in the teeth of the prehistoric framework of the Lewoleba and Liang Bua communities.	(Koesbardiati & Murti, 2019).
18.	*Perkembangan Analisis Fitolit dan Penerapannya dalam Arkeologi di Indonesia.* The Development of Phytolith Analyses and Its Application in Indonesian Archaeology.	Literature Studies.	Literature study /Phytolit microbotany data in archaeobotanic al research in Indonesia.	(A. W. Pratama, 2020).

19.	*Pemanfaatan Tumbuhan di Situs Doro Mpana, Dompu, Nusa Tenggara Barat Berdasarkan Analisis Fitolit pada Residu Gerabah.* The Utilization of Plants in Doro Mpana Site, Dompu, West Nusa Tenggara Based On Phytolith Analysis from Pottery Residue.	Doro Mpana Site.	Phytolith extracted from pottery fragment residue in the settlement context and concentrated pottery in the burial context/ Communities supporting the Doro Site, Mpana, Dompu, West Nusa Tenggara have used plants with evidence in the form of the presence of phytoliths on the tools used in funeral ceremonies.	(A. W. Pratama, 2020).
20.	*Strategi Penghidupan di Gua Here Sorot Entapa, Pulau Kisar, Maluku: Situs Hunian di Pulau Minim Sumber Daya.* Subsistence Strategy Of Here Sorot Entapa Cave In Kisar Island, Maluku: Dwelling Site in Island With Limited Terrestrial Resources.	Here Sorot Entapa Site.	Macro-botanical data (seeds) and micro-botanical data (pollen, phytolith, and starch). As well as a comparison of ecofact findings from animals and plants /The subsistence strategy of humans who once inhabited Kisar Island in the past with limited resources -- The pattern of plant utilization in Here Highlights Entapa Cave.	(Alifah and Mahirta, 2021).

21.	*Karakteristik Lingkungan Vegetasi Situs Kendenglembu, Banyuwangi Berdasarkan Analisis Fitolit.* Vegetation Characteristic of Kendenglembu Site, Banyuwangi Based On Phytolith Analysis.	Kendenglembu Site.	Phytolith in soil sediments from three excavation boxes, which are RJS TP I, KDL TP II, and KDL TP III.	(Arrozain, 2021).
22.	*Pemanfaatan Tumbuhan di Situs Plawangan Berdasarkan Analisis Residu pada Gerabah.* Plants Utilization in Plawangan Site Based On Pottery Residue.	Plawangan Site. obtained from	Phytolith the extraction process of pottery residue found in Plawangan excavations/ The use of plants by the people who supported the Plawangan Site does not only meet consumption needs but also various aspects that supported their lives.	(Rizky, 2021).
23.	*Song Gede: Situs Gua Hunian Sejak Masa Pleistosen Akhir di Pulau Nusa, Bali.* Song Gede: Dwelling Site Since Pleistocene Period in Nusa Island, Bali.	Gede Site.	Phytoliths derived from the extraction of residues on pottery fragments and phytoliths from sediments.	(Hidayah *et al*., 2021)

24.	*Variasi Vegetasi Situs Cenra Cenranae Sulawesi Selatan Berdasarkan Analisis Fitolit.* Vegetation Variety of Cenra Cenranae Site, South Sulawesi Based On Phytolith Analysis.	Cenra Cenranae Site.	Phytolith obtained from soil sediment excavated box Archaeological Center of South Sulawesi / Description of vegetation variations and possible utilization of plant resources through phytolith analysis at the Cenra Cenranae site, a residential niche site located in the Maros karst mountain area, Mallawa District, South Sulawesi.	(J. M. V. Hanindyo Perdana Y, 2022).
25.	*Pemanfaatan Sumber Daya Alam Masa Prasejarah Berdasarkan Temuan Arkeologis Gua Arca, Pulau Kangean, Jawa Timur.* Prehistory Natural Resources Utilization Based On Archaeological Finds at Arca Cave, Kangean Island, East Java.	Arca Cave Site.	Phytolith, starch, pollen, and diatoms were obtained from observations on artifact residues in the form of pottery, stone sharpening, blade flake sharpening, and bone spiking/ A not strategic environmental conditions as a place to live forced prehistoric humans who lived in Arca Cave to adapt to their surroundings, one of which was by utilizing plants.	(Alifah *et al*., 2022).

Source: Author, 2022

Table 1 shows that since 2012, archaeobotanical research in Indonesia has generally used phytoliths as data. 8% of the research presented in Table 1 uses an archaeobotanical approach as a complement to the main research topic.

3.2 Discussion

The emergence of archaeobotanical research in Indonesia is an indication of the development of Indonesian archeology in terms of its approach. Advances are accompanied by the development of research theories and analytical methods to address increasingly complex research questions asked by archaeologists(Kaharudin, 2019). Archaeobotanical research in Indonesia is inseparable from research conducted by foreign researchers, such as (Bowdery, 1999) Phytoliths from tropical sediments: Reports from Southeast Asia and Papua New Guinea and (Lentfer, 2009) Building a Comparative Starch Reference Collection for Indonesia and its Application to Palaeoenvironmental and archaeological research, both are widely used as references. Siswanto (2000) who wrote an article titled "Archaeobotanical Analysis in Archaeological Research in Indonesia" stated that phytolith analysis had not yet been carried out in Indonesia.

From 2000 to 2010 research using an archaeobotanical approach was carried out by foreign researchers collaborating with Indonesian researchers, such as Paz, Victor J. 2004 (Paz, 2004) who conducted a macro analysis of grains in Leang Burung, with the title "Of Nuts, Seeds, and Tubers: The archaeobotanical evidence from Leang Burung 1". Besides that, Semah, Anne-Marie., Francois Semah, Rachid Moudrikah, Francois Frohlich and Tony Djubiantono. 2004 (Sémah et al., 2004) did research in Ambarawa, Central Java by analyzing pollen under the title "A Late Pleistocene and Holocene Sedimentary Record I Central Java and its Paleoclimatic Significance". As this research focuses on Indonesian researchers, the foreign researchers discussed here are excluded from the following analysis.

Before 2000, archaeological researchers in Indonesia usually used pollen data. One of the pioneers, Vita, 1997, wrote an article titled "Plant Identification based on Pollen Characteristics: A Basis for Sediment Pollen Identification in Archaeology". However, microbotanical data in the form of pollen still has limitations due to the nature of pollen which is easily spread by the wind, so it may not originate from the site in situ, so pollen data is useful for describing the macro environment (Renfrew & Bahn, 2016), so that when phytolith analysis develops, much was done to complete pollen data.

A student's final project in 2007 by Fajari using a microbotanical approach was considered the pioneer (Fajari, 2007). A quite significant development in archaeobotanical research in Indonesia began in early 2012 with the dissertation of Anggraeni's research (Anggraeni, 2012) and there was also an analysis of the phytolith which became the starting point for the development of this analysis. Using references from Piperno, Dolores, 2006 (Piperno, 2006) a book titled "Phytoliths a Comprehensive Guide for Archeology and Paleoecologists", became the main reference in phytolith analysis which was mostly carried out in subsequent years by Gadjah Mada University students and archaeological researchers. This is also inseparable from the existence of a laboratory in the Gadjah Mada University Archeology Department, which supports carrying out this analysis. Currently, archaeological researchers in Indonesia are under the auspices of the Research Organization for Archaeology, Language, and Letters, National Research and Innovation Agency. After joining this institute, research collaborations are increasingly open, and implementation of analysis in the

laboratory is available, so it is hoped it will improve the quality of research, including archaeobotany.

Most of the research with this archaeobotanical approach originates from prehistoric sites and originates from residential cave sites. Cave sites or rock shelter sites present the best opportunity for preservation and deep continuous sequences. Archaeobotanical research that focuses on residential caves can find out that the cultural aspects become a factor as to why certain plants are found hidden in caves by knowing the conditions of the surrounding environment and accompanied by taking sediment samples (Alifah & Mahirta, 2021).

Figure 1 presents the development of archaeobotanical research in Indonesia. The tendency of researchers to use phytoliths as research data is due to the nature of phytoliths which are more resistant to changing environmental conditions so their existence is more common when compared to other types of microbotany data. The following (Figure 2) shows the development of the use of data types in archaeobotanical research in Indonesia.

The application of the archaeobotanical approach to Indonesian archaeological research in the future will provide a clearer picture of the dynamics of vegetation change over time from an archaeological site and also the use of vegetation by humans. The prospects for Indonesian archaeobotany aside from being able to further develop environmental archeology, by using increasingly developing technology, archaeobotany can be applied to research on topics other than archeology, for example, biology.

Archaeobotanical research that took place in Indonesia is sometimes aiming for more than one purpose. Figure 3 shows the trend in Indonesian archaeobotanical research to determine its purpose.

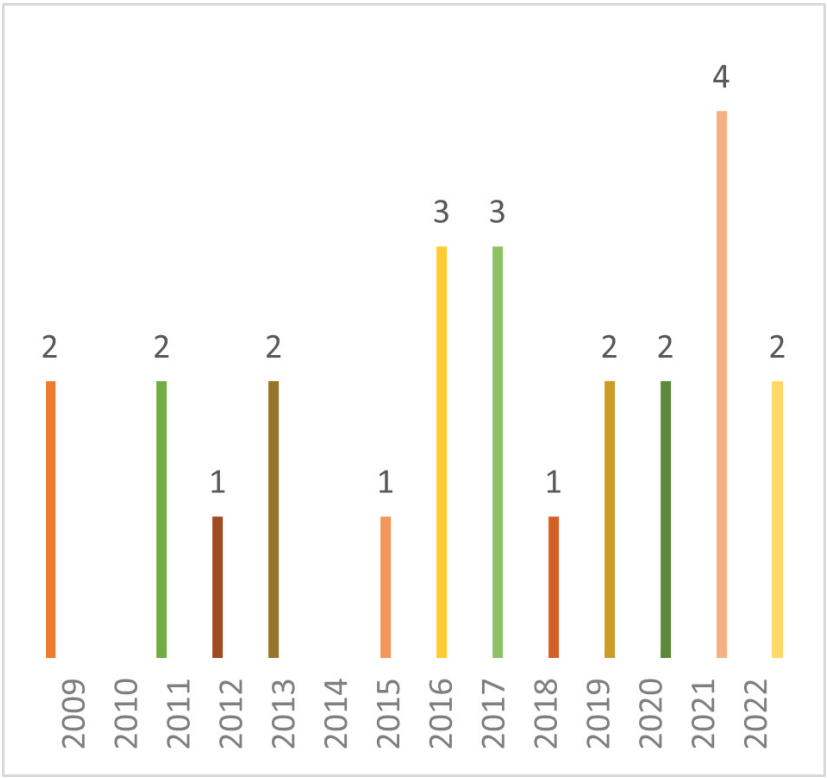

Figure 1. Development of Archaeobotanical Research in Indonesia from 2009 to 2022.
(Source: Author processed from various sources)

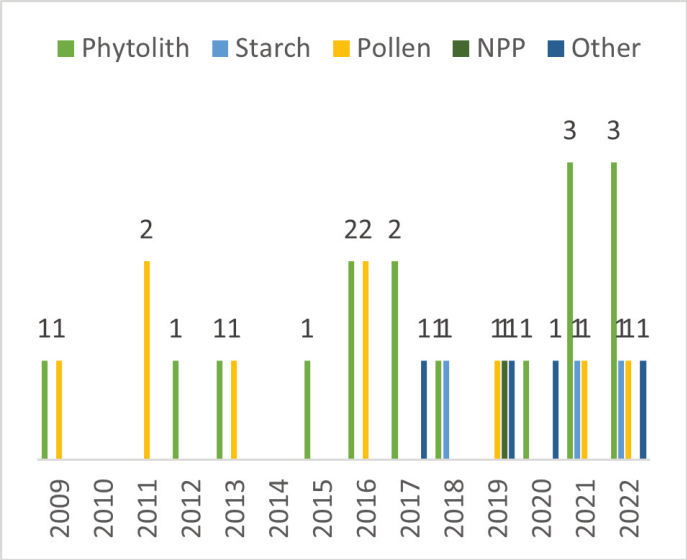

Figure 2. Development of the use of data types in Archaeobotanical Research in Indonesia from 2009 to 2022
(Source: Author processed from various sources)

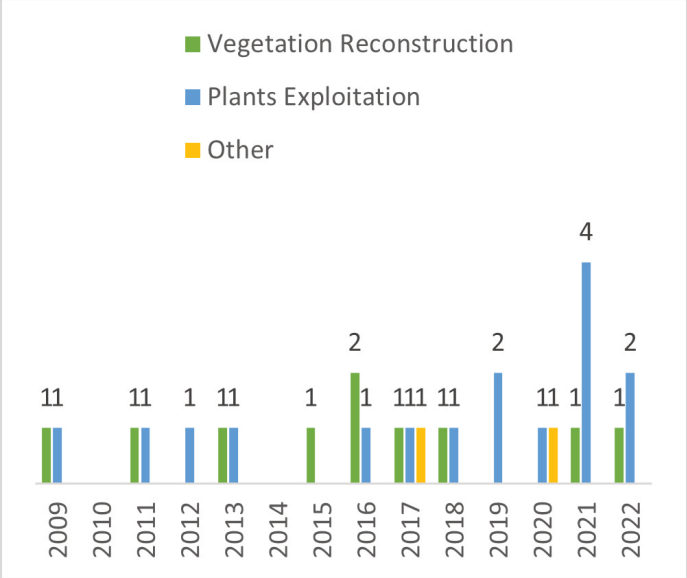

Figure 3. Development of Archaeobotanical Research in Indonesia from 2009 to 2022.
(Source: Author processed from various sources)

4. Conclusion

The archaeobotanical approach was introduced in Indonesia in 1990s and has developed since 2010 until now. There are now dozens of archaeological publications with this approach, using both macro and micro analysis which enrich archaeological interpretations in Indonesia. Archaeological research benefits from multi-proxy analysis to increase the reliability of the interpretation of individual lines of evidence from archaeological data. Archaeobotany is an approach that can be used and can be applied to all archaeological sites in Indonesia, both historical and prehistoric sites.

Author Declarations

Yasmin Lana Amara (YLA), Ati Rati Hidayah (ARH), Alifah (A), Fathimatuz Zahro

(FZ), and Adana Presti Ariyanto (APA) are the author. YLA, ARH, and A are the main authors. A and ARH conceptualized the paper and designed the study framework. YLA contributed to writing and completing papers. FZ and APA are the co-authors and contribute to data curation. All authors had read and approved the final manuscript.

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