

Original Paper

## **Collaborative Exploration of Solanaceae Vegetable Genetic Resources in Southern Cambodia, 2017**

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### **Summary**

The National Agriculture and Food Research Organization (NARO) and the Cambodian Agricultural Research and Development Institute (CARDI) have collaborated since 2014 under the Plant Genetic Resources in Asia (PGRAsia) project to survey the vegetable genetic resources available in Cambodia. As part of this project, three field surveys of Solanaceae crops were conducted in November 2014, 2015 and 2016 in western, eastern and northern Cambodia, respectively. In November 2017, we conducted a fourth field survey in southern Cambodia, including the Svay Rieng, Prey Veng, Kandal, Kampong Speu, Kou Kong, Sihanoukville, Kampot and Takeo provinces. We collected 56 chili pepper (20 *Capsicum annuum*, 36 *C. frutescens*) and 4 eggplant (4 *Solanum* spp.) fruit samples from markets, farmers' yards, farmers' fields and an open space. After harvesting seeds from the collected fruits, the seeds were divided equally and half were conserved in the CARDI and the other half were transferred to the Genetic Resource Center, NARO using the standard material transfer agreement (SMTA).

KEY WORDS: *Capsicum annuum*, *Capsicum frutescens*, chili pepper, eggplant, Cambodia

## Introduction

There are many genetic resources available in Southeast Asia for vegetables such as Solanaceae crops (Yamamoto and Nawata 2005; Matsunaga *et al.* 2010) and their great genetic diversity makes them a valuable resource for breeding programs (Saito *et al.* 2006; Matsunaga *et al.* 2015). However, there are few chili pepper genetic resources from Cambodia available worldwide (Matsunaga *et al.* 2015). Therefore, it is necessary to promote the collection and exploration of genetic resources in this area. Recently, chili pepper (*Capsicum* spp.) landraces traditionally cultivated in this region have been replaced by high-quality and high-yielding varieties imported from neighboring countries (Sugita *et al.* 2017). The genetic diversity among the crops grown in this region has subsequently begun to decrease, indicating the need to preserve and ensure the diversity of traditional landraces.

In July 2014, the National Agriculture and Food Research Organization (NARO) in Japan and the Cambodian Agricultural Research and Development Institute (CARDI) established a Joint Research Agreement (JRA) under the Plant Genetic Resources in Asia project (PGRAsia project) in trust of the Ministry of Agriculture, Forestry and Fisheries of Japan to preserve and ensure the effective use of genetic resources. As parts of the JRA, three Solanaceae crop field surveys were completed in Cambodia. The first survey was conducted in November 2014 in western Cambodia and covered a route through to the south of Tonlé Sap Lake (Matsunaga *et al.* 2015). The second survey was conducted in November 2015 in eastern Cambodia and included the Mondulkiri and Ratanakiri highlands (Tanaka *et al.* 2016). The third survey was conducted in November 2016 in northern Cambodia and covered a route through to the north of Tonlé Sap Lake (Sugita *et al.* 2017).

In the present survey, we visited southern Cambodia in November 2017 as the fourth survey and collected chili pepper and eggplant samples. This report presents the results of the fourth survey.

## Methods

A field survey was conducted in the southern region of Cambodia between 14<sup>th</sup> and 22<sup>nd</sup> November 2017 (Table 1, Fig. 1). The survey trip started in Phnom Penh on November 14<sup>th</sup>. We then explored the Svay Rieng, Prey Veng, Kandal, Kampong Speu, Kou Kong, Sihanoukville, Kampot and Takeo provinces. Survey activities included the collection of accessions (obtained in farmers' houses, backyards and fields, markets and an open field), interviews and plant observations. We used a car for transportation. When

Table 1. Itinerary followed during the 2017 survey in southern Cambodia

Date	Day	Itinerary	Stay
12-Nov	Sun	Chubu 11:00 (TG645) -- 15:40 Bangkok 18:20 (TG584) -- 19:35 Phnom Penh	Phnom Penh
13-Nov	Mon	Cambodian Agricultural Research and Development Institute (CARDI),	Phnom Penh
14-Nov	Tue	Phnom Penh -- Svay Rieng -- Bavet -- Svay Rieng	Svay Rieng
15-Nov	Wed	Svay Rieng -- Neak Loeung -- Kaoh Chek -- Neak Loeung -- Prey Veng	Prey Veng
16-Nov	Thu	Prey Veng -- Neak Loeung -- Kandal -- Ta Khmau -- Kandal -- Kampong Speu	Kampong Speu
17-Nov	Fri	Kampong Speu -- Tong Krouch -- Kampong Seila -- Koh Kong	Koh Kong
18-Nov	Sat	Koh Kong -- Ruessei Chrom -- Sihanoukville	Sihanoukville
19-Nov	Sun	Sihanoukville -- Kampot -- Chork -- Takeo	Takeo
20-Nov	Mon	Takeo -- Tani -- Kampong Trach -- Tani -- Rouminh -- Angk Prasat -- Takeo	Takeo
21-Nov	Tue	Takeo -- Prey Lvea -- Kampong Speu -- Tong Krouch -- Kampong Speu	Kampong Speu
22-Nov	Wed	Kampong Speu -- Phnom Penh	Phnom Penh
23-Nov	Thu	CARDI, Phnom Penh 20:35 (TG585) -- 21:40 Bangkok	on flight
24-Nov	Fri	Bangkok 00:05 (TG644) -- 7:30 Chubu	

we saw markets (Photo 1) and farmers' houses, we stopped and interviewed persons (Photo 2) regarding the local names, origins, cultivation and utilization of the chili pepper and eggplant accessions. During the survey, chili pepper and eggplant plant were observed throughout all provinces visited. In order to represent the variation in fruit appearance, origin and cultivation areas, we selected accessions to cover the diversity of the chili pepper and eggplant in the area. In farmers' backyards and fields, we attempted to collect mature fruit from one plant. In markets, we attempted to collect mature fruits that seemed, based on appearance, to be harvested from the same accession. After collecting the mature fruits, we harvested the seeds within 3 days. The identification of *Capsicum* species was based on a taxonomic key (Eshbaugh 2012). When a sample was collected we further recorded the place name and location information (latitude, longitude and altitude), which were determined using a global positioning system.

## Results

### Summary of samples collected

Sixty fruit samples were collected at the survey sites (6 markets, 1 open space, 28 farmers' backyards and 9 farmers' fields) in southern Cambodia. The samples consisted of 20 *C. annuum*, 36 *C. frutescens*, and 4 eggplants (*Solanum* spp.) (Tables 2 and 3). Table 3 shows detailed information for the accessions collected. The seeds were shared equally between NARO and CARDI.

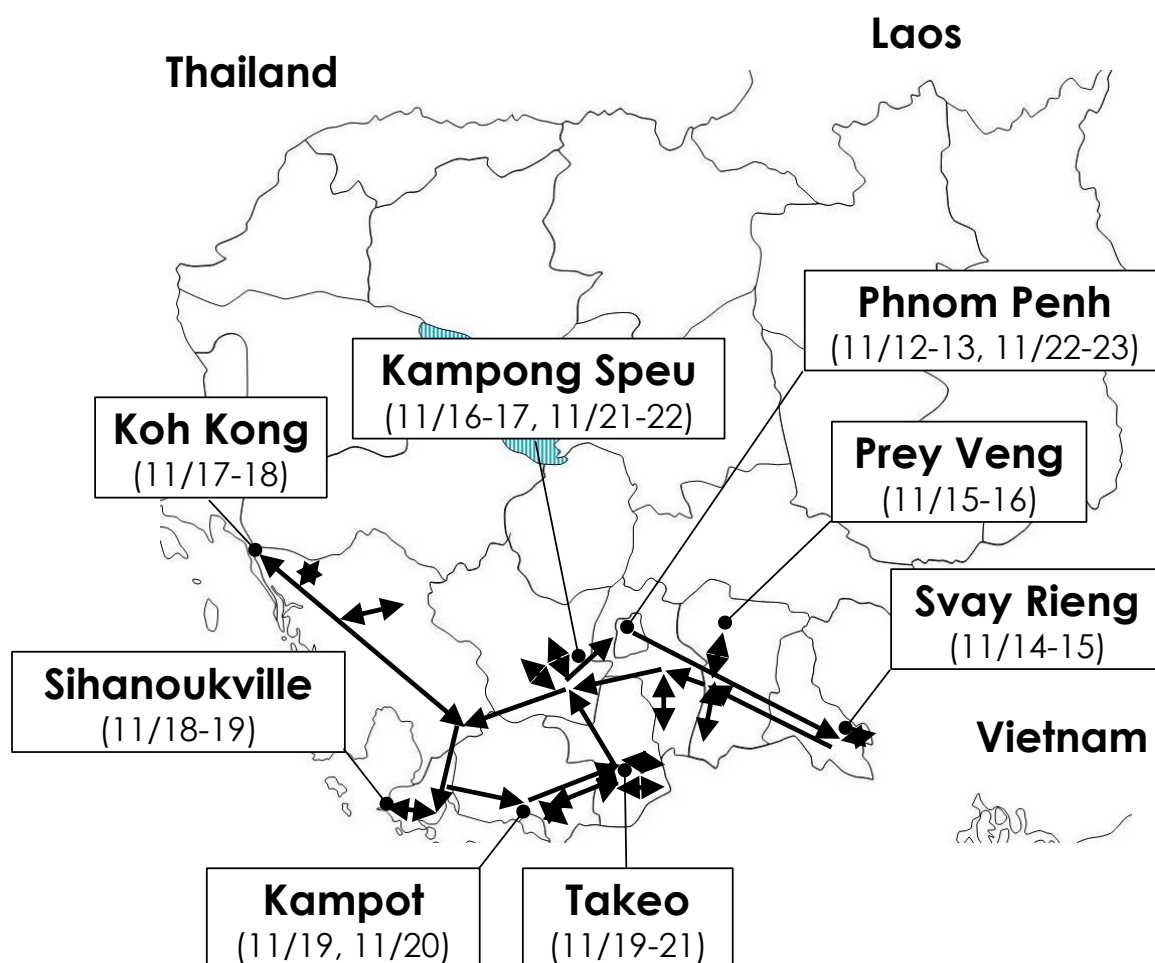


Fig. 1. The route of the fourth field survey 2017 in southern Cambodia.

Table 2. Samples collected during the 2017 survey in southern Cambodia

Collection site (province)	<i>C. annuum</i>	<i>C. frutescens</i>	<i>Solanum</i> spp.	Total
Svay Rieng	1	6	3	10
Prey Veng	4	3	0	7
Kandal	1	2	0	3
Kampong Speu	3	7	0	10
Koh Kong	2	5	0	7
Sihanoukville	1	2	0	3
Kampot	4	7	0	11
Takeo	4	4	1	9
Total	20	36	4	60

#### Daily record of the field survey

**14<sup>th</sup> November:** We left Phnom Penh and traveled east on Route 1 towards Svay Rieng province, in eastern Cambodia. We collected one chili pepper fruit sample (No. 1) from the Veal Youn market in Svey Rieng district. We then moved east on Route 1 to Bavet city, and we surveyed north of Route 1 in Bavet city, on the guidance of a local farmer. The chili peppers found at this site were not viable for sampling due to the high levels of rain received that year. We travelled back to Route 1 and on the way collected one eggplant fruit sample (No. 2), and one chili pepper fruit sample (No. 3) from different farmers. On the way to Svey Rieng, we collected one chili pepper fruit sample (No. 4) from a farmer along Route 1.

**15<sup>th</sup> November:** We explored the north side of Route 1 and found no chili peppers at the first two farms. The farmers reported that their chili peppers had died due to the heavy rains that season. We found a chili pepper sample in the backyard of the third farm visited (No. 5). Returning to Route 1, we collected two eggplant fruit samples (No. 6 and 7) and one chili pepper fruit samples (No. 8) from different farmers. We saw a farmer cultivating eggplants of the Vietnamese F<sub>1</sub> variety and we did not sample these. We then travelled to the south of Route 1. We collected two chili pepper fruit samples (No. 9 and 10) from different farmers and then travelled west along the Route 1. In Neak Loeung city in Prey Veng province we began to travel south and moved along Mekong river. On the way, we found some farmers cultivating chili pepper. We collected two chili pepper fruit samples (No. 11 and 12) from different farmers here, and one chili pepper fruit sample (No. 13) from a chili pepper field. The field belonged to a Vietnamese farmer who cultivated chili pepper varieties brought in from Vietnam. Travelling southward we interviewed a farmer who had no chili peppers but guided us to an open space where a large number of chili pepper plants grew. All of the plants and fruits were similar and so it was considered that they were derived from the same plant. We collected fruit samples (No. 14) from the plant that had the largest number of mature fruits.

**16<sup>th</sup> November:** In Prey Veng market there were very few chili peppers available and almost none of the species *C. frutescens*. In total we managed to collect three chili pepper fruit samples (No. 15-17). There were, however, many eggplants available, but almost all of these were immature and so we did not collect any samples. We then travelled south of Route 6A and Route 21. We saw fields of sugar cane, mango, etc. west side of Route 21. We collected one chili pepper fruit sample (No. 18) in a mango field, another (No. 19) from a chili pepper field, and a third (No. 20) from a farmer along Route 21. The chili pepper field where we collected No. 19 was managed by Vietnamese farmers and the chili peppers cultivated there were from Vietnam.

Subsequently we went to Kampong Speu province. In Kampong Speu province, a staff member of the provincial office assisted us. We went to an area north of Route 4 near Kampong Speu city where we collected four chili pepper fruit samples (No. 21-24).

**17<sup>th</sup> November:** With the same staff member from the Kampong Speu provincial office from the previous day, we visited chili pepper fields (Photos 3 and 4) on the north side of Route 4 where three kinds of chili pepper were cultivated: a single cultivar of “Mates Ploek”, and two different cultivars of “Mates Sor”. We collected two chili pepper fruit samples (No. 25 and 26). We also found a nearby field of eggplant called “Trop Veng”, but we could not find any mature fruits to sample. We also visited one more chili pepper field in which most of the plants were “Mates Ploek” and we were able to collect one chili pepper fruit sample (No. 27).

We drove to Kou Kong province via Route 4 and Route 48. A member of the Kou Kong provincial office assisted us in our exploration. In the center of Kou Kong city, we could not find any mature fruits of interest, but in the mountainous area we found a chili pepper field with a large number of cultivated plants (Photo 5), these plants had been grown from seeds harvested from a single *C. frutescens* plant, called “Mates Ach Sath”. There were a few mature fruits leftover from the harvest that we were able to sample (No. 28).

**18<sup>th</sup> November:** We surveyed the Dourg Thog market in Kou Kong city where there were a few fruits of *C. frutescens*, notably “Mates Sor”. We collected three chili pepper fruit samples (No. 29-31).

We drove back along Route 48 and turned left to a mountainous area. There were many banana fields in this area, and we identified a single chili pepper in a banana field from which we obtained a sample (No. 32). Subsequently we interviewed a banana farmer who had some small chili pepper fields that consisted mostly of “Mates Ach Sath” and he reported that many of his plants suffered damage caused by harmful insects. We selected healthy plants from his fields and obtained samples of two different kinds of fruits (No. 33 and 34). We then travelled back to Route 48 and on to Sihanoukville province via Route 48 and Route 4.

**19<sup>th</sup> November:** There were heavy rains during the night that continued on throughout the day. We first surveyed at the market in Sihanoukville city where we observed many kinds of *Capsicum* peppers, such as “Mates Die Neang”, “Mates Ploek”, “Mates Hawaii”, “Mates Ach Sath” and “Mates Sor”. We collected three chili pepper fruit samples (No. 35-37).

We drove to Kampot province on the Route 4 and 3 and on the way, we collected one chili pepper fruit sample (No. 38) from a farmer along Route 3. After arriving in Kampot province, we went to Samaki market in Kampot city. In this market, we identified various kinds of chili peppers and collected four chili pepper samples (No. 39-42).

We continued to travel along Route 3 and on the way collected two chili pepper samples from different farmers (No. 43 and 44). The rains became heavy enough that we had to end the days exploration and travelled straight to Takeo city.

**20<sup>th</sup> November:** There were heavy rains in the morning and subsequent flooding caused us to alter our planned route (Photo 6) from travelling south on Route 2 to travelling west on Route 114. We arrived at Tani Commune and continued to travel west on the Route 31. We stopped at a farmer’s house and collected one ornamental pepper fruit sample that was said to originate from Thailand (No. 45; Photo 7).

We travelled further along Route 31 and collected two chili pepper fruit samples from a farmer (No. 46 and 47). Among them, fruits of No.47 were not elect in spite of *C. frutescens*. Typical fruits of *C. frutescens* are generally elect. (Eshbaugh 2012). We then moved to Kampong Track where we collected one chili pepper fruit sample (No. 48) at a nearby farm. We travelled back to Tani and then east on Routes 114 and 111. We collected two ornamental chili pepper fruit samples (No. 49 and 50; Photos 8 and 9) on Route 111. No. 49 had flattened blocky type fruits like those of pumpkins and the farmer said that they both originated from Thailand.

We found a chili pepper field in the south of Takeo province. The field was supported by an 'IDE' that is a well-known company in Vietnam. The IDE group purchases all of the chili pepper fruits harvested from this field. There were three chili pepper varieties being cultivated and it was assumed that all three varieties were F<sub>1</sub> hybrids, and at least one variety was derived from Vietnam, and because of this we did not take samples of these peppers. We found some farmers that were located in close proximity to the IDE group field. Then we collected an eggplant and a chili pepper fruit sample (No. 51 and 52) from the different farmers.

**21<sup>st</sup> November:** In Takeo market we could see some chili peppers called "Mates Dai Neang" (*C. annuum*), but almost of all these plants were imported by the Roth Thmey Group, a Vietnamese company. Therefore, it was further assumed that almost of the other "Mates Dai Neang" in the market were also F<sub>1</sub> hybrids. We ultimately collected only one "Mates Dai Neang" fruit sample from the market (No. 53) because this particular sample was described by the seller as being harvested very locally and was perhaps from a landrace. We collected one more chili pepper fruit sample from this market (No. 54) of "Mates Ach Sath", as the farmer said that these fruits were harvested in the mountainous area in Takeo province and it was considered that they had also been harvested from a landrace plant. We then moved eastward and found a farmer who cultivated various kinds of chili peppers, such as "Mates Dai Neang", "Mates Ploek", "Mates Ach Sath", "Mates Sor", ornamental chili pepper, etc. We collected "Mates Ploek" (No. 55) and "Mates Sor" (No. 56) fruit samples here. We collected one more chili pepper fruit sample (No. 57) from a neighboring farm. In the south of Cambodia, particularly Takeo province, we found many ornamental chili peppers and were informed by local farmers that they were used as both ornaments and as a food.

We then travelled to Kampong Speu and from there moved north on Route 44. We collected three chili pepper samples here (No. 58-60). No. 58 was "Mates Dai Neang", and was collected from a plant that had germinated naturally in farmer's backyard, No. 59 was "Mates Sor", harvested in the mountain area and No. 60 was "Mates Ach Sath", harvested from a plant grown from a local market fruits seed.

**22<sup>nd</sup> November:** In Kampong Speu market almost of the "Mates Dai Neang" were imported from Vietnam and supported by Vietnamese companies. Some "Mates Sor" were harvested in the mountains of Kampong Speu, and almost all of the "Mates Ploek" were imported from Thailand. "Mates Ach Sath" was not found in this market.

After exploration of the Kampong Speu market, we travelled back to Phnom Penh.

**23<sup>rd</sup> November:** We reported the results of our field survey to CARDI, and we divided the collected dried seeds equally. Half were conserved in the CARDI and the other half were transferred to the Genetic Resource Center, NARO using the standard material transfer agreement (SMTA).

## Discussion

We conducted the forth collaborative explorations of Solanaceae vegetables, mainly *Capsicum*, genetic resources in Cambodia. In the present survey, 56 chili pepper and 4 eggplant accessions were collected from southern Cambodia (Tables 2 and 3). The chili pepper accessions consisted of 2 species, 20 *C. annuum* and 36 *C. frutescens*. Globally there are five major domesticated *Capsicum* species; *C. annuum*, *C. frutescens*, *C. chinense*, *C. baccatum* and *C. pubescens* (Bosland and Votava 1999). In the previous three explorations, 169 *Capsicum* accessions have been collected, including 66 *C. annuum* and 103 *C. frutescens* (Matsunaga *et al.* 2015; Tanaka *et al.* 2016; Sugita *et al.* 2017), but none of the other known domesticated *Capsicum* species have been located in any of our sampling sites. These results suggest that *C. annuum* and *C. frutescens* are the major cultivated species in Cambodia, and the other *Capsicum* species are not widely used. However, as cultivated *C. chinense* plants were found in Myanmar and Laos (Saito *et al.* 2006; Matsunaga *et al.* 2011; Okuizumi *et al.* 2016), two countries that are in the same region as Cambodia, we may in future begin to find *C. chinense* accessions in Cambodia.

The 20 accessions identified as *C. annuum* included 10 accessions of “Mates Dai Neang”, four of “Mates Ploek”, three each of “Mates Malay” and “Mates”. “Mates” means *Capsicum* pepper, “Dai Neang” means “ring finger”, “Ploek” means “bladder” and “Malay” means “Malaysia” in Khmer (Yamamoto *et al.* 2011; Matsunaga *et al.* 2015; Tanaka *et al.* 2016; Sugita *et al.* 2017). “Mates Dai Neang” is one of the most observed *Capsicum* peppers in both farmers’ backyards and the markets. Most of the “Mates Dai Neang” fruits are horn shaped (5 to 7 cm-long and 0.8 to 1.0 cm-wide), brilliant red in color and have a smooth surface (Photo 10). However, it was suggested in interviews in the local markets that “Mates Dai Neang” were not traditional accessions of Cambodia and were probably imported from Vietnam or Thailand. Some farmers said that the traditional Cambodian “Mates Dai Neang” were dull red in color and had a more rugged surface. “Mates Ploek” were also collected in the first and second surveys, and most of their fruits are corn shaped (6 to 10 cm-long and 2.5 to 3.5 cm-wide; Photo 11), and either only slightly pungent or not pungent. In the past two surveys, we collected them from markets only, but in this survey, we collected them directly from farmers’ fields. Although the farmers said that the fruits or seeds of these accessions were derived from near markets, it was considered that these most likely originated from Thailand. “Mates Malay” was also collected in the first and second surveys. Almost of all fruits were long-horn shapes (10 to 15 cm long and 1.0 to 1.5 cm wide), brilliant red in color and had smooth surfaces (Photo 12). In the first, second and present surveys, we collected them only from local markets and not from farmers’ backyards or fields. Some farmers in the markets said that almost all of the “Mates Malay” were introduced from Malaysia and it was suggested that “Mates Malay” is not widely cultivated in Cambodia. We also collected three accessions of *C. annuum* as “Mates”. These “Mates” were difficult to categorize into any of the known Cambodian *Capsicum* groups. They were cultivated as ornamental plants and were derived from Thailand. Two of these accessions were oval and pointy in shape of fruit top, and the color of the immature fruit were light greenish yellow (Photo 8). The other accession had pumpkin shaped fruits (Photo 7) and was also known as an ornamental. In the past three surveys, we did not observe ornamental *Capsicum* plants and it was suggested that the ornamental *Capsicum* plants are only cultivated in the southern areas of Cambodia. We did observe a blocky type of sweet pepper in some of the local markets (Photo 13), that was called “Mates Hawaii” in Khmer. They were not collected for the present survey as they were all F<sub>1</sub> hybrids. We observed a large diversity of *C. annuum* in the south areas of Cambodia, but there were also many imported accessions, and a few traditional ones. To find traditional accessions further explorations

away from the major cities and into the more rural and isolated areas would be advised.

The 36 accessions identified as *C. frutescens* included 20 accessions of “Mates Ach Sath”, 14 of “Mates Sor” and one each of “Mates Kmang” and “Mates”. “Ach Sath” means “bird dropping”, “Sor” means “white or light color” and “Kmang” means “spicy or very hot” in Khmer (Yamamoto and Nawata 2005; Matsunaga *et al.* 2015; Tanaka *et al.* 2016; Sugita *et al.* 2017). “Mates Ach Sath” and “Mates Sor” were the most observed *C. frutescens* in the present survey. In the previous 3 surveys, the 102 accessions identified *C. frutescens* including 45 accessions of “Mates Ach Sath” and 20 accessions of “Mates Sor”. It was suggested that “Mates Ach Sath” and “Mates Sor” were main cultivars of *C. frutescens* in Cambodia. Most of all fruit of “Mates Ach Sath” are horn shape (2 to 5 cm-long and 0.3 to 0.5 cm-wide), glassy color, smooth surface and sharp shape of fruit top (Photo 14). In a farmer’s field in Kou Kong province, we observed many “Mates Ach Sath” plants being cultivated (No. 28; Photo 5). All of these plants were progenies from only one plant that was selected by the farmer as a promising individual. It was suggested that selective breeding of the “Mates Ach Sath” cultivar has already begun in Cambodia. While improved *Capsicum* pepper varieties from breeding are good for Cambodian farmers, they may also result in reduced genetic diversity. Most of the “Mates Sor” fruits are horn shaped (2 to 5 cm-long and 0.5 to 0.7 cm-wide), dull in color, have an unsmooth surface, rounded shape to top of their fruits and their immature fruit color is ivory or light greenish yellow (Photo 15). A large diversity in fruit shape, fruit size, immature fruit color and so on were observed, indicating that a large diversity remained in the Cambodian genetic resource of “Mates Sor”. “Mates Kmang” (No. 10; Photo 16) collected in the present survey was similar to “Mates Ach Sath”, but smaller in size. “Mates” also collected in this survey are similar to “Mates Sor” in appearance.

We could also collect 4 eggplant accessions. In eggplant fields, the elongated type of eggplant was mainly cultivated and harvested during its immature stage (Photo 17), because Cambodian people usually use the immature eggplant fruits for foods. The fruit shapes of the eggplants cultivated in the fields varied from elongated to long egg-shaped. It was suggested that these were segregating populations from F<sub>1</sub> hybrids and thus they were difficult to collect as genetic resources from farmers’ fields. However, in some farmers’ backyards, we identified some circler type of eggplants (Photo 18) and were able to collect some as mature fruits.

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# 2017 年カンボジア南部における ナス科野菜遺伝資源の共同探索

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## 和文摘要

農業・食品産業技術総合研究機構（NARO）とカンボジア農業開発研究所（CARDI）は、カンボジア国内における野菜類を中心とした遺伝資源を探索するため、PGRAsia（Plant Genetic Resource in Asia）プロジェクトのもと、2014 年から共同研究を実施している。本プロジェクトの一環として、2014 年、2015 年および 2016 年の 11 月に、それぞれカンボジアの西部、東部および北部地域において、3 回のナス科作物の探索を実施した。2017 年 11 月に我々は、カンボジア南部地域の Svay Rieng, Prey Veng, Kandal, Kampong Speu, Kou Kong, Sihanoukville, Kampot および Takeo 州において、4 回目の探索を実施した。本探索において、20 点の *Capsicum annuum*, 36 点の *Capsicum frutescens* および 4 点の *Solanum* spp. からなる合計 60 点のトウガラシおよびナスを市場や農家の裏庭等で収集した。収集した種子は 2 等分し、半分は CARDI で保存し、残りの半分は SMTA (Standard Material Transfer Agreement) により NARO のジーンバンクに移送した。

Table 3. List of *Capsicum* and eggplant samples collected in Cambodia during the 2017 survey

No.	Collection No.	Passport No.	JP No.	JP Name	Date	Genus & Species	Province /State	District	Commune	Village	North latitude/ East longitude	Altitude (m)	Source (Market name)	Status	Local name	Remarks
1	1	30072288	260071	COL/CAMBODIA/2017/NIVTS/001	Nov.14	<i>Capsicum frutescens</i>	Svay Rieng	Svay Rieng City	Svay Rieng	Svay Rieng	11-04-57/ 105-47-40	8	Market (Veal Youn)	landrace	Mates Ach Sath	from Bavet
2	2	30072289	260072	COL/CAMBODIA/2017/NIVTS/002	Nov.14	<i>Solanum</i> spp.	Svay Rieng	Bavet City	Thiok	Thiok	11-04-44/ 106-04-15	5	Farmer's House/ backyard	landrace	Trop Sroy	from Bavet market
3	3	30072290	260073	COL/CAMBODIA/2017/NIVTS/003	Nov.14	<i>Capsicum annuum</i>	Svay Rieng	Bavet City	Thiok	Thiok	11-03-53/ 106-04-10	13	Farmer's House/ harvested fruits	landrace	Mates Dai Neang	from Vietnam
4	4	30072291	260074	COL/CAMBODIA/2017/NIVTS/004	Nov.14	<i>Capsicum frutescens</i>	Svay Rieng	Bavet City	Thiok	Thiok	11-02-43/ 106-04-02	7	Farmer's House/ backyard	landrace	Mates Ach Sath	from Kamgpong Cham
5	5	30072292	260075	COL/CAMBODIA/2017/NIVTS/005	Nov.15	<i>Capsicum frutescens</i>	Svay Rieng	Chanthrea	Chambak	Chambak	11-06-09/ 105-45-46	6	Farmer's House/ backyard	landrace	Mates Sor	from near market
6	6	30072293	260076	COL/CAMBODIA/2017/NIVTS/006	Nov.15	<i>Solanum</i> spp.	Svay Rieng	Svay Chrom	Tro Sus	Phnov	11-05-58/ 105-45-37	13	Farmer's House/ backyard	landrace	Trop Sroy	from near farmer
7	7	30072294	260077	COL/CAMBODIA/2017/NIVTS/007	Nov.15	<i>Solanum</i> spp.	Svay Rieng	Svay Chrom	Tro Sus	Phnov	11-05-53/ 105-45-36	2	Farmer's House/ backyard	landrace	Trop Khar	
8	8	30072295	260078	COL/CAMBODIA/2017/NIVTS/008	Nov.15	<i>Capsicum frutescens</i>	Svay Rieng	Svay Chrom	Tro Sus	Phnov	11-05-27/ 105-45-39	9	Farmer's House/ backyard	landrace	Mates	cultivated more than one year
9	9	30072296	260079	COL/CAMBODIA/2017/NIVTS/009	Nov.15	<i>Capsicum frutescens</i>	Svay Rieng	Svay Rieng City	Phray Thlock	Andaung Ryy Srei	11-06-10/ 105-47-24	9	Farmer's House/ backyard	landrace	Mates Ach Sath	cultivated more than two years
10	10	30072297	260080	COL/CAMBODIA/2017/NIVTS/010	Nov.15	<i>Capsicum frutescens</i>	Svay Rieng	Chanthrea	To Tea	To Tea	11-06-51/ 105-46-57	15	Farmer's House/ backyard	landrace	Mates Khmag	a farmer keeps the seeds for a long time
11	11	30072298	260081	COL/CAMBODIA/2017/NIVTS/011	Nov.15	<i>Capsicum frutescens</i>	Prey Veng	Kaoh Chek	Kaoh Chek	Shpen	11-02-34/ 105-12-34	13	Farmer's House/ backyard	landrace	Mates Ach Sath	a farmer keeps the seeds for a long time
12	12	30072299	260082	COL/CAMBODIA/2017/NIVTS/012	Nov.15	<i>Capsicum frutescens</i>	Prey Veng	Kaoh Chek	Kaoh Chek	Shpen	11-03-27/ 105-12-27	11	Farmer's House/ backyard	landrace	Mates Ach Sath	from chap village
13	13	30072300	260083	COL/CAMBODIA/2017/NIVTS/013	Nov.15	<i>Capsicum annuum</i>	Prey Veng	Kaoh Chek	Kaoh Chek	Shpen	11-03-25/ 105-12-49	9	Farmer's field (pepper field)	landrace	Mates Dai Neang	from Vietnam
14	14	30072301	260084	COL/CAMBODIA/2017/NIVTS/014	Nov.15	<i>Capsicum frutescens</i>	Prey Veng	Kaoh Chek	Mean Chey	Mean Chey	11-04-23/ 105-12-51	4	wild	weedy	Mates Ach Sath	weeds in space near Mekong River
15	15	30072302	260085	COL/CAMBODIA/2017/NIVTS/015	Nov.16	<i>Capsicum annuum</i>	Prey Veng	Kampong Trabaek	Kampong Trabaek	Bei	11-29-07/ 105-19-22	12	Market (Prey Veng)	landrace	Mates Dai Neang	from Phnom Penh
16	16	30072303	260086	COL/CAMBODIA/2017/NIVTS/016	Nov.16	<i>Capsicum annuum</i>	Prey Veng	Kampong Trabaek	Kampong Trabaek	Bei	11-29-06/ 105-19-20	9	Market (Prey Veng)	landrace	Mates Dai Neang	from Neak Loeung
17	17	30072304	260087	COL/CAMBODIA/2017/NIVTS/017	Nov.16	<i>Capsicum annuum</i>	Prey Veng	Kampong Trabaek	Kampong Trabaek	Bei	11-29-07/ 105-19-20	3	Market (Prey Veng)	landrace	Mates Malay	from Phnom Penh
18	18	30072305	260088	COL/CAMBODIA/2017/NIVTS/018	Nov.16	<i>Capsicum frutescens</i>	Kandal	S'ang	Preaek Koy	Svay Tany	11-20-23/ 105-00-36	9	Farmer's field/ edge of mango field	landrace	Mates Sor	naturally germinated
19	19	30072306	260089	COL/CAMBODIA/2017/NIVTS/019	Nov.16	<i>Capsicum annuum</i>	Kandal	S'ang	Preaek Koy	Svay Tany	11-20-16/ 105-00-26	10	Farmer's field (pepper field)	landrace	Mates Dai Neang	from Vietnam
20	20	30072307	260090	COL/CAMBODIA/2017/NIVTS/020	Nov.16	<i>Capsicum frutescens</i>	Kandal	S'ang	Tike Vil	Phrey Tara	11-19-25/ 105-01-58	14	Farmer's House/ backyard	landrace	Mates Sor	naturally germinated
21	21	30072308	260091	COL/CAMBODIA/2017/NIVTS/021	Nov.16	<i>Capsicum frutescens</i>	Kampong Speu	Samraong Tong	Kahaeng	Toum Poug	11-26-30/ 104-26-57	36	Farmer's House/ backyard	landrace	Mates Sor	from near market
22	22	30072309	260092	COL/CAMBODIA/2017/NIVTS/022	Nov.16	<i>Capsicum frutescens</i>	Kampong Speu	Samraong Tong	Kahaeng	Rieng Chray	11-26-45/ 104-26-59	36	Farmer's field (pepper field)	landrace	Mates Sor	from near market, sell near market
23	23	30072310	260093	COL/CAMBODIA/2017/NIVTS/023	Nov.16	<i>Capsicum frutescens</i>	Kampong Speu	Samraong Tong	Kahaeng	Rieng Chray	11-26-31/ 104-26-58	37	Farmer's House/ backyard	landrace	Mates Ach Sath	from near market

Table 3. (Continued).

No.	Collection No.	Passport No.	JP No.	JP Name	Date	Genus & Species	Province /State	District	Commune	Village	North latitude/ East longitude	Altitude (m)	Source (Market name)	Status	Local name	Remarks
24	24	30072311	260094	COL/CAMBODIA/2017/NIVTS/024	Nov.16	<i>Capsicum frutescens</i>	Kampong Speu	Samraong Tong	Kahaeng	Rieng Chray	11-26-31/ 104-26-58	37	Farmer's House/ backyard	landrace	Mates Sor	from near market
25	25	30072312	260095	COL/CAMBODIA/2017/NIVTS/025	Nov.17	<i>Capsicum annuum</i>	Kampong Speu	Samraong Tong	Tang Krouch	Som Rith	11-27-03/ 104-25-05	42	Farmer's field (pepper field)	landrace	Mates Ploek	from near market
26	26	30072313	260096	COL/CAMBODIA/2017/NIVTS/026	Nov.17	<i>Capsicum frutescens</i>	Kampong Speu	Samraong Tong	Tang Krouch	Som Rith	11-27-03/ 104-25-05	42	Farmer's field (pepper field)	landrace	Mates Sor	from near market
27	27	30072314	260097	COL/CAMBODIA/2017/NIVTS/027	Nov.17	<i>Capsicum annuum</i>	Kampong Speu	Samraong Tong	Tang Krouch	Som Rith	11-27-08/ 104-24-04	43	Farmer's field (pepper field)	landrace	Mates Ploek	
28	28	30072315	260098	COL/CAMBODIA/2017/NIVTS/028	Nov.17	<i>Capsicum frutescens</i>	Koh Kong	Khemarak Phoumin	Smach Mean Chey	Boeng Khun Chhang	11-37-03/ 103-02-06	109	Farmer's field (pepper field)	landrace	Mates Ach Sath	from a plant kept more than 2 years
29	29	30072316	260099	COL/CAMBODIA/2017/NIVTS/029	Nov.18	<i>Capsicum annuum</i>	Koh Kong	Khemarak Phoumin	Smach Mean Chey	Phum Ti Bei	11-36-32/ 102-58-52	13	Market (Dourg thog)	landrace	Mates Dai Neang	from Phnom Penh
30	30	30072317	260100	COL/CAMBODIA/2017/NIVTS/030	Nov.18	<i>Capsicum annuum</i>	Koh Kong	Khemarak Phoumin	Smach Mean Chey	Phum Ti Bei	11-36-32/ 102-58-52	13	Market (Dourg thog)	landrace	Mates Malay	from Phnom Penh
31	31	30072318	260101	COL/CAMBODIA/2017/NIVTS/031	Nov.18	<i>Capsicum frutescens</i>	Koh Kong	Khemarak Phoumin	Smach Mean Chey	Phum Ti Bei	11-36-32/ 102-58-52	13	Market (Dourg thog)	landrace	Mates Ach Sath	from Thmor Baug District in Koh Kong Province
32	32	30072319	260102	COL/CAMBODIA/2017/NIVTS/032	Nov.18	<i>Capsicum frutescens</i>	Koh Kong	Thma Bang	Ruessei Chrum	Kokir Chrum	11-39-04/ 103-24-12	346	Farmer's field (banana field)	landrace	Mates Ach Sath	natural germinated in banana field
33	33	30072320	260103	COL/CAMBODIA/2017/NIVTS/033	Nov.18	<i>Capsicum frutescens</i>	Koh Kong	Thma Bang	Ruessei Chrum	Kokir Chrum	11-39-27/ 103-24-20	354	Farmer's field (banana field)	landrace	Mates Ach Sath	natural germinated in banana field
34	34	30072321	260104	COL/CAMBODIA/2017/NIVTS/034	Nov.18	<i>Capsicum frutescens</i>	Koh Kong	Thma Bang	Ruessei Chrum	Kokir Chrum	11-39-27/ 103-24-20	354	Farmer's field (banana field)	landrace	Mates Ach Sath	natural germinated in banana field. bigger fruits than 33.
35	35	30072322	260105	COL/CAMBODIA/2017/NIVTS/035	Nov.19	<i>Capsicum frutescens</i>	Siha-noukville	Sihanoukville City	Sangkat Buon	-	10-37-20/ 103-31-51	47	Market (After)	landrace	Mates Sor	from Phnom Penh
36	36	30072323	260106	COL/CAMBODIA/2017/NIVTS/036	Nov.19	<i>Capsicum annuum</i>	Siha-noukville	Sihanoukville City	Sangkat Buon	-	10-37-20/ 103-31-51	47	Market (After)	landrace	Mates Dai Neang	from Phnom Penh
37	37	30072324	260107	COL/CAMBODIA/2017/NIVTS/037	Nov.19	<i>Capsicum frutescens</i>	Siha-noukville	Sihanoukville City	Sangkat Buon	-	10-37-20/ 103-31-51	47	Market (After)	landrace	Mates Ach Sath	from near here
38	38	30072325	260108	COL/CAMBODIA/2017/NIVTS/038	Nov.19	<i>Capsicum frutescens</i>	Kampot	Tuek Chhou	Boeng Tuk	Totueng Thngai	10-34-46/ 104-09-07	13	Farmer's House/ backyard	landrace	Mates Ach Sath	natural germinated
39	39	30072326	260109	COL/CAMBODIA/2017/NIVTS/039	Nov.19	<i>Capsicum annuum</i>	Kampot	Kampot City	Kampong Bay	Kampong Bay	10-36-58/ 104-10-50	9	Market (Samaki)	landrace	Mates Malay	from Phnom Penh
40	40	30072327	260110	COL/CAMBODIA/2017/NIVTS/040	Nov.19	<i>Capsicum annuum</i>	Kampot	Kampot City	Kampong Bay	Kampong Bay	10-36-58/ 104-10-50	9	Market (Samaki)	landrace	Mates Dai Neang	from Phnom Penh
41	41	30072328	260111	COL/CAMBODIA/2017/NIVTS/041	Nov.19	<i>Capsicum frutescens</i>	Kampot	Kampot City	Kampong Bay	Kampong Bay	10-36-58/ 104-10-50	9	Market (Samaki)	landrace	Mates Sor	from Kampot
42	42	30072329	260112	COL/CAMBODIA/2017/NIVTS/042	Nov.19	<i>Capsicum annuum</i>	Kampot	Kampot City	Kampong Bay	Kampong Bay	10-36-58/ 104-10-50	9	Market (Samaki)	landrace	Mates Ploek	from Kampong Cham
43	43	30072330	260113	COL/CAMBODIA/2017/NIVTS/043	Nov.19	<i>Capsicum frutescens</i>	Kampot	Dang Tong	Shrang	Bern	10-44-42/ 104-20-44	37	Farmer's House/ backyard	landrace	Mates Sor	bought seedlings from hear here
44	44	30072331	260114	COL/CAMBODIA/2017/NIVTS/044	Nov.19	<i>Capsicum frutescens</i>	Kampot	Chhouk	Chhouk	Khro Sang	10-49-20/ 104-26-04	29	Farmer's House/ backyard	landrace	Mates Sor	from near market
45	45	30072332	260115	COL/CAMBODIA/2017/NIVTS/045	Nov.20	<i>Capsicum annuum</i>	Kampot	Angkor Chey	Tani	Tani	10-46-48/ 104-39-41	24	Farmer's House/ backyard	landrace	Mates	from Thailand, for ornamental, slightly purple flower
46	46	30072333	260116	COL/CAMBODIA/2017/NIVTS/046	Nov.20	<i>Capsicum frutescens</i>	Kampot	Banteay Meas	Saam Rngleu	Damnak Chambak	10-44-25/ 104-35-54	19	Farmer's House/ backyard	landrace	Mates Ach Sath	natural germinated

Table 3. (Continued).

No.	Collection No.	Passport No.	JP No.	JP Name	Date	Genus & Species	Province /State	District	Commune	Village	North latitude/ East longitude	Altitude (m)	Source (Market name)	Status	Local name	Remarks
47	47	30072334	260117	COL/CAMBODIA/2017/NIVTS/047	Nov.20	<i>Capsicum frutescens</i>	Kampot	Banteay Meas	Saam Rngleu	Damnakh Chambak	10-44-25/ 104-35-54	19	Farmer's House/ backyard	landrace	Mates Sor	natural germinated, fruits are not elect
48	48	30072335	260118	COL/CAMBODIA/2017/NIVTS/048	Nov.20	<i>Capsicum frutescens</i>	Kampot	Kampong Trech	Preaek Kroes	Preaek Kroes	10-32-25/ 104-35-20	11	Farmer's House/ backyard	landrace	Mates Ach Sath	from near market
49	49	30072336	260119	COL/CAMBODIA/2017/NIVTS/049	Nov.20	<i>Capsicum annuum</i>	Takeo	Kaoh Andaet	Thlea Chroum	Andoung Somrith	10-47-50/ 104-52-57	5	Farmer's House/ backyard	landrace	Mates	from Thailand, for ornamental, pumpkin shape fruit
50	50	30072337	260120	COL/CAMBODIA/2017/NIVTS/050	Nov.20	<i>Capsicum annuum</i>	Takeo	Kaoh Andaet	Rou Minh	Kirichong Koh	10-47-60/ 104-56-18	10	Farmer's House/ backyard	landrace	Mates	from Thailand for ornamental
51	51	30072338	260121	COL/CAMBODIA/2017/NIVTS/051	Nov.20	<i>Solanum spp.</i>	Takeo	Kiri Vong	Angk Prasat	Phnom Rothas	10-45-26/ 104-47-55	9	Farmer's House/ backyard	landrace	Trop Sroy	natural germinated
52	52	30072339	260122	COL/CAMBODIA/2017/NIVTS/052	Nov.20	<i>Capsicum frutescens</i>	Takeo	Kiri Vong	Angk Prasat	Phnom Rothas	10-45-26/ 104-47-55	9	Farmer's House/ backyard	landrace	Mates Ach Sath	natural germinated
53	53	30072340	260123	COL/CAMBODIA/2017/NIVTS/053	Nov.21	<i>Capsicum annuum</i>	Takeo	Donk Keo City	Roka Krau	Yhnoul Bombeak	10-58-50/ 104-46-40	11	Market (Takeo)	landrace	Mates Dai Neang	from near here
54	54	30072341	260124	COL/CAMBODIA/2017/NIVTS/054	Nov.21	<i>Capsicum frutescens</i>	Takeo	Donk Keo City	Roka Krau	Yhnoul bombeak	10-58-50/ 104-46-40	11	Market (Takeo)	landrace	Mates Ach Sath	from near mountain area
55	55	30072342	260125	COL/CAMBODIA/2017/NIVTS/055	Nov.21	<i>Capsicum annuum</i>	Takeo	Prey Kabbas	Chambak	Preaek Thumei	11-09-53/ 104-54-13	10	Farmer's House/ backyard	landrace	Mates Ploek	from near market
56	56	30072343	260126	COL/CAMBODIA/2017/NIVTS/056	Nov.21	<i>Capsicum frutescens</i>	Takeo	Prey Kabbas	Chambak	Preaek Thumei	11-09-53/ 104-54-13	10	Farmer's House/ backyard	landrace	Mates Sor	from near market
57	57	30072344	260127	COL/CAMBODIA/2017/NIVTS/057	Nov.21	<i>Capsicum frutescens</i>	Takeo	Prey Kabbas	Prey Lvea	Prey Lvea	11-09-43/ 104-57-37	13	Farmer's House/ backyard	landrace	Mates Ach Sath	from farmer's field closed here
58	58	30072345	260128	COL/CAMBODIA/2017/NIVTS/058	Nov.21	<i>Capsicum frutescens</i>	Kampong Speu	Samraong Tong	Tang Krouch	Au Neang Heing	11-32-36/ 104-23-56	68	Farmer's House/ backyard	landrace	Mates Ach Sath	natural germinated
59	59	30072346	260129	COL/CAMBODIA/2017/NIVTS/059	Nov.21	<i>Capsicum frutescens</i>	Kampong Speu	Samraong Tong	Tang Krouch	Okoki	11-31-52/ 104-24-55	59	Farmer's House/ backyard	landrace	Mates Sor	from near mountain area
60	60	30072347	260130	COL/CAMBODIA/2017/NIVTS/060	Nov.21	<i>Capsicum annuum</i>	Kampong Speu	Samraong Tong	Tang Krouch	Santiphap Thmey	11-31-31/ 104-25-32	56	Farmer's House/ backyard	landrace	Mates Dai Neang	from near market



Photo 1. Typical vegetable market in Cambodia. This is a part of Takeo market, in Takeo Province.



Photo 2. An interview with a farmer in Prey Veng Province.



Photo 3. Two kinds of *Capsicum* pepper cultivations in Kampong Speu Province. Top left is “Mates Sor” and bottom right is “Mates Ploek”.



Photo 4. The enlarged figure of “Mates Ploek” in the Photo 3.



Photo 5. “Mates Ach Sath” field in Koh Kong Province.



Photo 6. Flooded road in Takeo Province.



Photo 7. An ornamental *Capsicum* plant (No. 45) in Kampot Province.



Photo 8. An ornamental *Capsicum* plant (No. 49) in Takeo Province. Its fruits are pumpkin shaped.



Photo 9. Ornamental *Capsicum* plants (No. 50) in Takeo Province.



Photo 10. Fruits of "Mates Dai Neang" (bottom) in Prey Veng markets.



Photo 11. Immature fruits of "Mates Ploek" (bottom) in Kampong Speu market.



Photo 12. Fruits of "Mates Malay" (center) in Prey Veng market.



Photo 13. Blocky type of sweet pepper, called “Mates Hawaii” in Khmer, in Sihanoukville market.



Photo 14. “Mates Ach Sath” (No. 34), cultivated in a field closed to a banana field, in Koh Kong Province.



Photo 15. “Mates Sor” (No. 18) in a farmer’s back yard in Kandal Province.

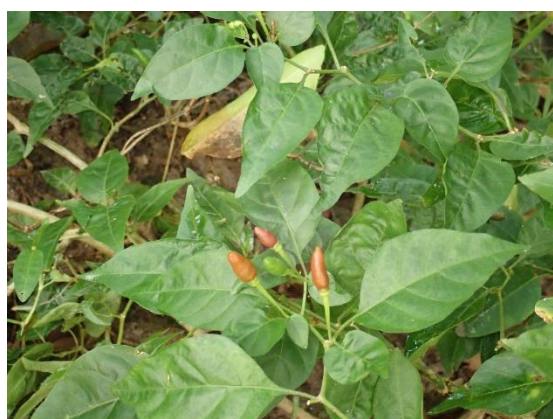


Photo 16. “Mates Kmang” (No. 10) in Svay Rieng Province.



Photo 17. Elongated type of eggplants, in Kampong Speu Province.



Photo 18. Circler type of eggplants (No. 2), in Svay Rieng Province.