Original Strategy for Verbatim Collecting Knowledge from Mostly-Illiterate and Secretive Experts: West Africa Traditional Medicine's Case

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Abstract—**80% of least developed countries populations rely on traditional medicine (TM). West Africa is not left outdone. Multilingualism is very manifest. Additionally, TM practitioners (TMP) commonly desire to keep secret their knowledge. Illiteracy affects the vast majority of TMP in this region. Thus, exchanges between practitioners for knowledge and experience sharing are severely hindered by multilingualism, illiteracy and secretiveness. The reliability and relevance question of the data and knowledge gathered from these practitioners is therefore raised. Conventional data collection methods are not operational in this context. Hence, we designed an original collection data method that we called back-and-forth, to overcome these difficulties. Such method allows us to obtain stable and verbatim collection from the TMP. Both sequential and recursive, it is applied to data collection during visits carried out for 110 practitioners in West Africa, with two to four visits per practitioner. 79 practitioners were finally included in the study project. The others 31 either did not adhere to the project or provided unstable knowledge. 13 diseases and 12 plants were collected, with the "plant cure disease" relations between them, as expressed by these 79 practitioners. Our second objective was to extend the domain ontology of west Africa TM, accurately ontoMEDTRAD, due to the emergence of three new concepts arising from the above. Face to climate change that may lead to some plants extinction, to update some old reference sources contents of TM, it has proved necessary to compare them with the opinions and knowledge collected from TMP.**

Keywords—Knowledge elicitation; collection data method; ontology; traditional medicine; West Africa; ontoMEDTRAD

I. INTRODUCTION

For their healthcare, 80% of the least developed countries populations, and particularly those in West Africa, rely on traditional medicine (TM) [1]. TM is complementary to conventional medicine (CM), and is often easier to access, cheaper, and culturally closer to these populations. TM commonly consists in the use of therapeutic plants with few chemical transformations [2], if any. However, most TM practitioners (TMP) have not followed any dedicated training [3]. The TM knowledge transmission mostly relies on oral communication. TMP have mean age, higher than life expectancy. Thus, they usually disappear with their TM knowledge [4]. At the same time, as modernization continues,

some local languages are threatened with extinction [5, 6, 7, 8, 9]. Consequently, in order to perpetuate TM knowledge [10, 11, 36, 37, 38, 39], it is mandatory to write and formalize the knowledge from TMP using textbooks, training courses, or even decision support tools based on information and communication technologies (ICT). The first step toward this formalization is knowledge elicitation [34, 35], in verbatim format, i.e. raw written traces.

However, many difficulties arise when collecting knowledge and data in the context of TM. That situation is described in three points: 1) multilingualism: there are more than 1000 spoken languages in West Africa [5, 6, 12]; 2) illiteracy: the vast majority of TMP do not both read and write in any of the three official languages (English, French and Portuguese) [12, 13]; 3) secretiveness: many TMP keep their knowledge secret and are not opened to share it with their colleagues [12, 13, 14].

Given all the above, conventional and regular data collection methods [16, 17] are not operational in such context. In this respect, the reliability of the data and knowledge collected depends highly on the reliability of the method.

In this paper, we propose a specific method to collect knowledge and data in a context of multilingualism, illiteracy and secretiveness. The method is based on more than one interview (also said interview visit) for the same TMP. We thus called it "back and forth".

In the course of our data collection using this method, the *recruited* TMP are gradually divided into *included* TMP and *excluded* TMP. Following the knowledge elicitation, we also enriched and extended our ontology of traditional medicine, ontoMEDTRAD, with three new concepts: Translator, TMP advising on references of TM source, and References of TM sources.

The data collected in this work can also be of great interest from an ecological point of view. For example, one of the recommendations is that the most widely used TM plants should be protected as a priority against extinction and the dangers of climate change.

For the following, we first describe the background context to this work. Then, we detail our method and the results from

statistical and ontological angles. Finally, we discuss our work and conclude.

II. CONTEXT AND BACKGROUND

Multilingualism constitutes a wealth of habits and customs [18, 19] in several regions of the least developed countries. In West Africa, there are about 1127 local languages, including 527 in Nigeria alone [12, 18, 20]. These languages are rarely written. This constitutes a real language barrier in oral and written exchanges. English, French and Portuguese are the three non-local, so-called official written languages used for intra- and inter-country communication. At the level of education and training, the primary, secondary and higher schools in these countries of the African Sub-region are based essentially on these official languages [24]. Despite advances in the current education level in each of these countries, the majority of expert TMPs are not literate [4, 18, 21, 22] in these official languages. In addition, naturally, we note the tacit character of this African TM [10, 23]. The schools of TM are almost non-existent. Their number is very low [10, 23]. Mutual sharing of knowledge and experience between TMPs is not usual. When some knowledge transfer takes place, it is done orally [10, 23]. Lineage, innateness, recognition and gratitude provide a solid foundation for the reasons for these transmissions [10, 23]. In this part of the world, TMP organizations remain more like social self-help associations and federations. They allow also TMP to dialogue and exchange with public structure (e.g: PNPMT) and non-public one as non-government organization (NGO) (e.g : Prometra) [10]. Their purpose does not include professional exchanges based on knowledge and experience sharing specific to traditional medical art. This situation seems to continue over time. Furthermore, TM is a sensitive issue. The culture of secrecy is strongly shared by TMPs [12], both custodians and holders of rooted knowledge in the art of TM.

In all this context, the collection of information, knowledge and data from these mostly illiterate TMP is more than problematic. We are therefore opting for information and communication technologies (ICTs), which are clearly among the most important tools for making the most of information and enriching knowledge. As part of our strategy, we have therefore built innovative technological tools such as the ontoMEDTRAD an ontology and the SysMEDTRAD decision support system [4, 10] to sustain and preserve TM knowledge. The complexity of capturing african TM justifies the progressive, incremental and modular nature of the construction of these tools, a step in a major project to safeguard local, community, cultural and professional knowledge in West Africa [4].

In the light of all the above, the quality of our innovative tools depends to a large extent on the quality of the collected information, data and knowledge. This led us to establish a particular method of this collecting from the TMP. It is a method that allows us to have the verbatim data and knowledge of this TM. This method contrasts sharply with traditional and regular collection ones which cannot be operational, simply because of multilingualism, illiteracy and secretiveness.

III. "BACK AND FORTH" METHOD

The specificity of the back-and-forth method is the replication of similar interviews, in order to achieve stability of the data and knowledge collected from the TMPs. Indeed, several interviews (at least two and at most four) are conducted with a given TMP until the stability of the data and knowledge gathered is assured. Sequential and recursive, the method potentially reduces the semantic bias between on the one hand the knowledge and its interpretation, and on the other those ones of the reality perceived held by the TMP. It is also possible to make implicit knowledge, explicit thanks to the inference system, the reasoner, which is an essential feature in the design and especially in the use of an ontology [32].

The steps of our method are outlined by what follows.

A. Recruitment of TMP and Translators

In order to recruit TMPs, we propose the use of facilitating structures such as governmental TM promotion agencies (e.g: PNPMT, a public structure in Abidjan) and NGOs (e.g: PROMETRA in Dakar). These structures are able to provide lists of TMPs, with whom they work regularly and with whom contact is easy. We also suggest contacting TMP associations and federations. They can provide signed letters of introduction and investigation. These letters are an element that can simplify subsequent interviews, even if most TMPs cannot read. We suggest that the presidents of the associations and federations should be approached first, as they can read and know the importance of such letters. These public and private structures are also in contact with translators, who should be recruited to carry out the exchanges with the TMPs. The translators will be part of the interviewers together as the interviewers of the study. TMPs are mostly men. TMP women number is very low.

In our elicitation technique used, the translator takes into account the general features of the TMP's habits and customs.

B. Awareness-Raising Meeting

We propose organizing an awareness-raising meeting with all the TMPs recruited for the study. At this meeting, the objectives of the study are presented, as well as the expected results for the TMP. The TMPs are given instructions, in particular to adopt a pedagogical attitude towards the investigators (interviewers). Indeed, TMPs are often afraid that researchers will just come and collect their knowledge without any direct benefit to them. In response term, an advantage for the TMPs selected and included in this research study is to give them access to the software tools for sharing the knowledge which will be produced (acquired). The principle of repeated interviews is also explained, pointing out that feedback on certain knowledge is essential in order to consolidate and stabilize it.

C. Preparing for the Interviews

The individual interviews and the paper questionnaire for data and knowledge collection should be prepared (see example of Fig. 5 of questionary forms in annexes). These questionnaires have to be filled in by the interviewers mostly time.

D. Conducting the Interviews

The interviews are conducted individually, with one TMP at a time.

For some TMPs, it is useful to provide a modest or bloc, such as a drink, at the beginning or the end of the interview. During

the interview, we ask the TMP to list the five of health problems (diseases) that he treats most frequently. He/she must also list the medicinal resources (plant, mineral and animal) that he/she uses to cure each of these problems. In order to be able to identify the plants correctly, we ask them to show us the plants. These plants are compared with the assessments of botanists to verify or determine their scientific name. In this regard, we have recourse to monographs on West African medicinal plants [24, 25, 26, 27, 28, 29, 30]. These cited monographs are not exhaustive.

At the time of the interview, the TMP is asked general questions (e.g. surname, first name and speciality, his education level, number of patients per day, per month, per year, etc.), and questions relating to the health care practices provided and knowledge related to this care. We recommend not making audio or video recordings, as the TMP are reluctant to do so and may get angry if they are recorded.

The same interview is repeated at least twice and at most four times with the same TMP, in order to ensure the stability of the knowledge collected. Repeating the interviews, approximately every three months, makes it possible to clarify the points that remain ambiguous, but also, from the second interview onwards, to compare the knowledge collected with that of the previous interviews to determine the stability of the knowledge expressed. It is then possible to present the TMP with his own contradictions and to evaluate the interviews as a whole (behaviour and explanations). At the end of each interview, the TMP is classified into one of the following three categories:

"excluded TMP", "TMP to be revisited" and "included TMP". TMP cannot be classified as "included TMP" or "TMP to be revisited" at the first or the very last interview, respectively. We give some details on these three categories noted by (1), (2) and (3).

1) Excluded TMP: These are TMPs excluded for one of the following reasons:

a) TMP's absence from the interview scheduled with his agreement;

b) Lack of willingness to participate in the study, often resulting in digressions or even excessive rambling by the TMP himself (herself);

c) Collected data and knowledge that are contradictory or not stable over the course of the meetings.

Here is an example of an "unwilling" TMP. In a village in Senegal, an appointment was made with a traditional healer. The translator and I arrived in the healer's courtyard, where he usually works. First, we found his wife there. After the usual greetings, she asked us to wait for her husband who was in the house. Ten minutes later, the healer comes out and greets us from a distance. Without any further exchange, he went back to his house. As the wait was getting long, his wife went back to see him. She finally came out to tell us that her husband could no longer honor the appointment. Thus, we had left the place empty-handed.

Here is a second example of the instability of the knowledge expressed by the TMP. At the first appointment, a TMP certified the use of the neem plant (Azadirachta indica) for the treatment

of malaria (paludism). At the second meeting, he did not even mention malaria among the five diseases he treats most often.

2) TMP to be revisited: This group of TMPs is committed to the project. The exchanges are going well. This decision is not applicable to the last interview, as the "TMP to be revisited" is an interim decision, and not a final one.

3) Included TMP: The data collected are stable over the meetings. They are consistent with the contents of the books, and of good quality. In these data, knowledge and experience of TMP are often included after a few discussions with him.

However, after the first interview, it is not possible to make a comparison due to the lack of previous collections. Therefore, the stability of knowledge cannot be assessed at all. The TMP cannot be included after only one interview. Therefore, there are at least two interviews for each TMP in order to make the decision on which TMP to include. Similarly, after the fourth and final interview, the TMP must necessarily be either included or excluded. If the knowledge is still not stabilized at this stage, we recommend excluding the TMP. Table I illustrates the different successive interviews (RDVi , for i from 1 to 4) and the possible decisions following an interview. The Included TMP (IT) are fully committed to the project.

TABLE I. Type of Decision Taken for a TMP by Stage of the Interviews Cycle (From Beginning to End) Specific to that TMP

N° of interview appointment with the same TMP	Possible decisions at the interview issue
RDV1	ET, TBR
RDV2	IT, ET, TBR
RDV3	IT, ET, TBR
RDV4	IT, ET

Legend: ET: Excluded TMP; IT: Included TMP; TBR: TMP to be revisited. Notice: three months is the estimated period between two interviews with the same TMP.

It is not necessary for all TMPs to be at the same stage of interview. As far as the four appointments are concerned, there is a period of at least three months between two interview visits to the same TMP.

It is only at the end of the campaign of data collection that we can draw accounting conclusions about the final number of included or excluded TMPs. The duration of our campaign of TMP data collection and knowledge acquisition was one year and a half.

E. Techniques for Refining this Method Multiple Confrontations

Our collections focus mainly on plants which constitute the largest proportion of all medicinal resources in TM of in west Africa. The plants collected are identified with the public structures and NGOs help. Local botanist teachers can also intervene for certain confirmations in addition to the confrontations with Internet sources and other sources such as books. They have a reference list of plants with their corresponding vernacular names in local languages and scientific names.

We also pursue these comparisons through the use of monographs on West African medicinal plants [14, 24, 25, 26, 27, 28, 29, 30]. When scientific name of a plant used by a TMP is unknown, we approach a university botanist. For the same reason, we can solicit botanists from botanical gardens in conjunction with universities. We also use monographs [24, 26] supported by the advice of facilitating state structures (e.g: PNPMT).

For this purpose, during our collection visits to the TMP, photographs of plant parts such as leaves are used to contribute to identify the plant scientific name.

Some stabilized data and knowledge collected from included TMP are synthesized and compared with that found in recent books and other miscellaneous sources. For certain intermediate validations, this collection is essential for all the modeling stages (conceptualization, formalization, operationalization) involved in any ontology construction methodology (Neon, Diligent, OntoForInfoScience, …) [10, 37, 40]. However, the knowledge of the TM recorded in older reference sources (e.g. before 2000) may differ with the practices of current TMP. This can be explained by the extinction of certain plants or medicinal resources as a result of climate change, e.g. due to reduced rainfall, or by anthropic actions in relation to the overuse of traditional and medicinal resources (plant, mineral and animal).

IV. RESULTS

We recruited a total of 110 TMPs. 50 were Ivorian and 60 were Senegalese. In Côte d'Ivoire, we relied on the National Program for the Promotion of Traditional Medicine (PNPMT). In Senegal, we received support from the University of Gaston Berger (UGB) in Saint-Louis and the NGO Prometra.

In addition, some of the TMPs we visited led us to contact additional TMP. For example, after our interview with one TMP, this one led us to a more reputed other. The list of TMP, thus, grew over the course of the study to reach 110.

We also recruited two translators, one in Côte d'Ivoire and one in Senegal, each translating several local languages.

The awareness meetings in Côte d'Ivoire and Senegal were similar. The Ivorian TMP received a short training in anatomy, the content of which was provided by a medical doctor (physician).

The duration of the interviews varied from one TMP to another. For the first meeting, it ranged from one to three hours, depending on the TMP's interest in the study. After this first appointment, subsequent interviews are of shorter duration, ranging from 25 minutes to 1 hour. On the other hand, for some TMPs, the final interviews tend to be of slightly longer duration as their interest grows over the course of these interviews. During these interviews, we were surprised by the wealth of knowledge collected. Some of the speeches distanced us from a cartesian and scientific approach. They deal with concepts relating to metaphysics or the supernatural (djinn or djinan means genius in form of water, fire, stone, mountain, wind, etc.).

For example, one TMP told us that he could find any plant in the West African sub-region, no matter where it was growing. However, he didn't explain to us the technique he uses to quickly obtain a plant that only grows very far away. We put aside these speeches without really taking them into account. Many TMPs find it difficult to separate the physical and bodily dimension from the psychological and societal dimension of the disease. We have tried as much as possible to focus on the somatic (physical and bodily) dimension of human health and not on the holistic approach [10] that TM claims. This somatic dimension is currently more measured. The repeated interviews were not conducted in waves, but as the TMPs were recruited. The TMPs were therefore not all at the same stage at any given time. The Fig. 1 shows the inclusion and exclusion decisions made at the end of each of all forth interviews. Inclusion decisions are made at the end of each of the last three interviews. This means that such a decision can only be taken at the end of second interview, and immediately after the first interview phase (RDV1), no TMP was included. This is justified by the back-and-forth nature of our collection method. We need at least two interviews with the same TMP to make a comparison and assess the stability of the knowledge collected in order to decide.

The very first "excluded TMP" were excluded because they did not keep their appointments or showed signs of total absence of adherence to the research project. On the margins of our interviews with the TMP, our curiosity led us to ask and have aside the opinion of patients who came to consult the TMP. They told us that they were satisfied with the TMP's health care. Some of the most open-minded TMPs have asked us for advice on how to help them certify the active ingredients in their products, or even on how to register patent.

A. Statistics on Information and Knowledge Gained from Interviews

Figures numbered from 1 to 3, illustrate this back-and-forth method. In Fig. 1, each bar of the diagram represents one of the four interview visits, denoted RDVn (n being an index going from 1 to 4). Interview RDVn is achieved after interview RDVn-1, with n greater than 1. The height of the bars in Fig. 1 represents the number of TMPs. At the end of the four interview phases, 31 TMPs (28%) were excluded and 79 TMPs (72%) were included. Table II shows these totals for TMPs admitted as ITs or as ETs, as well as the progressive trends from which they are calculated.

The TMPs were asked to identify the five most frequent plants they use, and the five most frequent diseases they treat. After eliminating duplicates, 12 medicinal plant species in TM were observed in TMP prescriptions for health care treatment. From the same interviews, 13 diseases were identified as being cited by the TMPs. We found a high degree of overlap: the same plants are used or prescribed by most TMP, and most TMPs treat the same diseases. We noted that malaria is the most common disease treated by the TMPs. Tables III and IV list respectively the diseases and plants with the number of times they were mentioned by distinct TMP.

As TM is not an exact science, there is not a 1-1 mapping between plants and diseases. Various TMPs may cite the same plants, but to treat different diseases, or may cite the same disease, but treat it with different plants. It is therefore important to quantify the number of TMP that cited each plant-disease association. For this purpose, Fig. 2 and Fig. 3 show diagrams

of the number of citations obtained from TMP resulting from Tables III and IV, respectively.

Whether, it is a plant or a disease, the number of times it is cited is that of the TMPs having cited it.

The Table V shows the exhaustive citations numbers between plants and diseases. For instance, one can see that Azadirachta indica A. Juss. (Neem) was cited 14 times for treating paludism, which suggests a high confidence. On the contrary, the same plant was cited only once for treating diarrhea

and edema, which is associated with a much lower confidence. In all cases, we have the stability of the information obtained. From the data and knowledge collected, other outcomes as the emergence of three concepts to integrate in ontoMEDTRAD, arise. ontoMEDTRAD's construction method [10] based on the other three, namely Neon, Diligent and OntoforIinfoscience, justifies the point of transition between this first part and the second which follows.

TABLE II.   NUMBER OF DECISION TYPES TAKEN ON TMP BY THE STAGE OF THE INTERVIEWS CYCLE (FROM BEGINNING TO END)

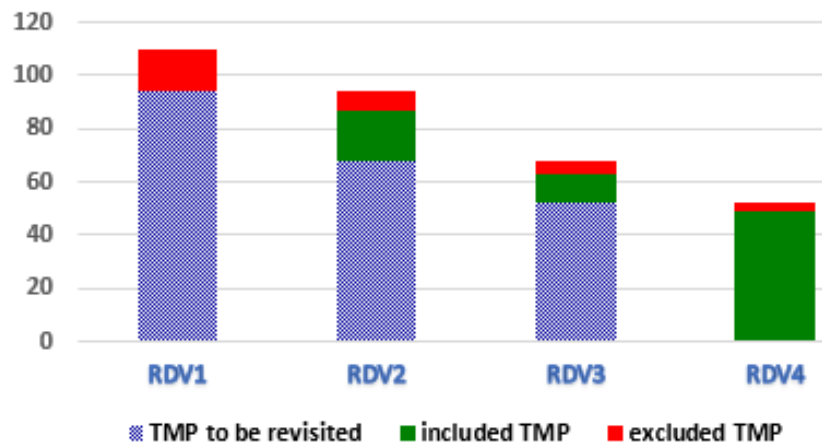|		N° of interviews visit to TMP				Totals
		RDV1	RDV2	RDV3	RDV4	
Number of decision types taken on TMP	TMP to be revisited : **TBR**	94	68	52	0	
	Included TMP : **IT**	0	19	11	49	79
	Excluded TMP : **ET**	16	7	5	3	31

Fig. 1.   Distribution diagram of TMP after each of the four interview meetings is linked to Table II.

TABLE III.   NUMBER OF TMPS HAVING CITED A GIVEN HEALTH PROBLEM (SYMPTOM/SIGN/DISEASE) IN THEIR HEALTH CARE PLAN

| Scientific name of disease	Abbrev	Local popular name	Number of TMPs having cited the disease
Paludism	Palu	malaria	50
hypertension	HT	high blood pressure, human nerve problem	47
Fontanel	Font	opened fontanel	37
Stomach ulcer	Ulcer	belly or stomach wound	36
Common cold and flu	Cold	common cold	33
Fever	Fever	hot warm body	33
Diarrhea	Diar	bowel problem, running belly	31
Rheumatism	Rheum	bone problem	30
Dermatophytosis	Derm	rashes, itching and fungus	30
Anemia	Anem	lack of blood	27
Edema	Edema	inflammatory edema	18
Diabetes	Diab	excess of sugar in blood	17
Tooth Decay	Tooth	toothache	06
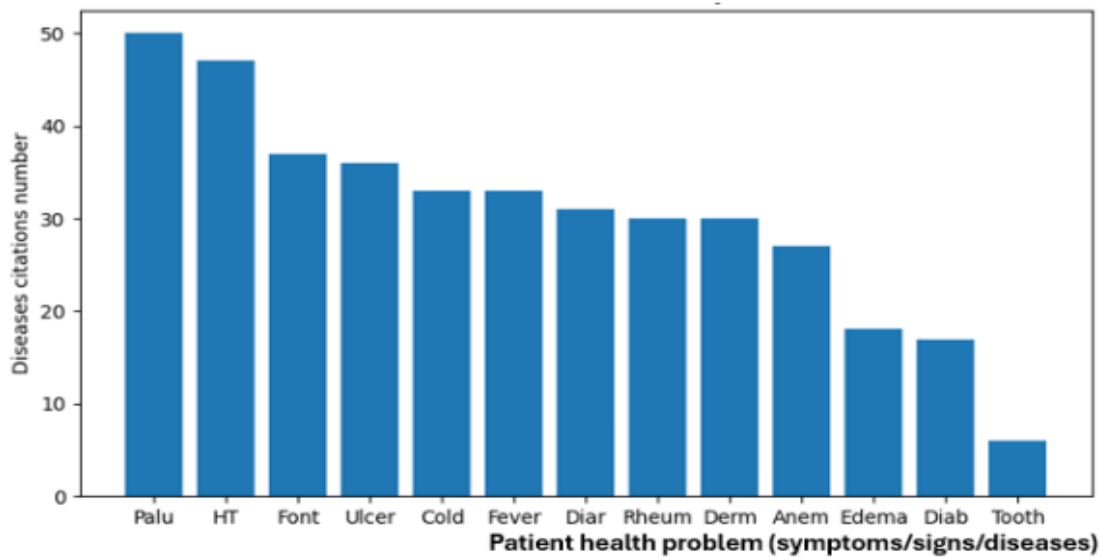
Fig. 2.   A diagram for the number of TMPs having cited a given health problem (symptom/sign/disease) in their health care plan is linked to Table III.

TABLE IV.   LIST OF PLANTS CITED BY TMPS, AND THE NUMBER OF CITATIONS

| Scientific name of TM plant	Abbrev	Local popular name	Number of TMPs having cited the TM plant
Azadirachta indica A. Juss. (Meliaceae)	Neem	Neem	51
Coco nucifera L.(Arecaceae)	Coco	Coconut	44
Citrus aurantifolia (Christm) Swingle (Rutaceae)	Lemon	Lemon, Lemon Tree	42
Cymbopogon citratus (DC) Stapf (Poaceae)	Cit	Citronella	36
Acacia nilotica (L.) Will (Mimosaceae)	Red	Red gum tree	33
Carica papaye(L.) (Caricaceae)	Pap	Papaya	33
Manihot eculenta Crantz(Euphorbiaceae)	Cas	Cassava	32
Cambretum micranthum G. Don (Combretaceae)	Kin	Kinkeliba	30
Moringa oleifera Lam (Moringaceae)	Mor	Moringa	30
Senna occidentalis (L.)Link (Caesalpiniaceae)	Cof	Coffee break, negro coffee, coffee senna	29
Hibiscus sabdariffa (L.) (Malvaceae)	Bis	Bissap	22
Nephrolepis biserrata (Sw) schott (Nephrolepidaceae)	Giant	Giant sword ferm	13
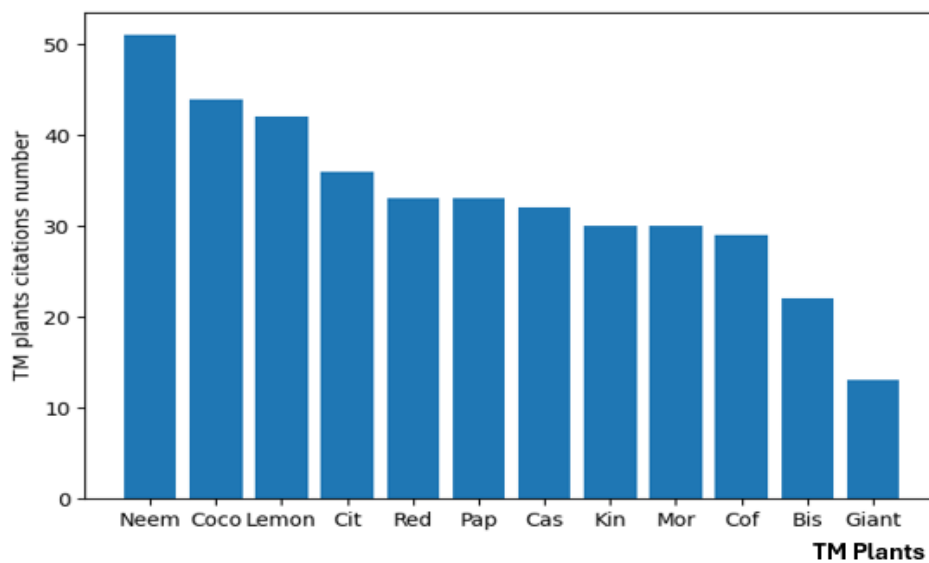
Fig. 3.   Diagram for the number of TMPs having cited a given TM plant in their health care plan is linked to Table IV.

TABLE V. EXHAUSTIVE RELATIONS BETWEEN PLANTS AND DISEASES DETAILED BY CITATIONS NUMBER

		Plants												#dis-tinct plants	# citations totals
		Neem	Coco	Lemon	Cit	Red	Pap	Cas	Kin	Mor	Cof	Bis	Giant		
Diseases	Palu	14	2	4	3	3	5	3	4	3	1	5	3	12	50
	HT	6	4	4	2	8	7	5		5	2	4		10	47
	Font	4	7		4		8			3	6		5	7	37
	Ucler	3	4	4	5	5	1	5	2	6	1			10	36
	Cold	5	3	7		4	2	4	4		4			8	33
	Fever	7	4	2	3	4	1	3	1	4		4		10	33
	Diar	1	5	7	1	3	3	4	4	3				9	31
	Rheum	4	3	4	2	2	2	3	2		4	4		10	30
	Derm	3		4	4	3	2		3	4	5	2		9	30
	Anem	3	6	5	5				2		5		1	7	27
	Edema	1	2	1	1	1	1	5	4	1		1		10	18
	Diab		4		4				2	1	1	1	4	7	17
	Tooth				2		1		2			1		4	6
	#distinct diseases	11	11	10	12	9	11	8	11	9	9	8	4		
	#total citations	51	44	42	36	33	33	32	30	30	29	22	13		Total: 395 citations

B. Addition of New Concepts to the Ontology of Traditional Medicine, OntoMEDTRAD

This second part, far from being opposed to the previous one, is a consequence of it. None of the ontology development methods has been adopted to date [10, 36, 38, 39, 40], but for now the emphasis is on the main objectives of sharing semantic of concepts and common standards (for axiomatization of concepts), co-construction and mutual understanding for a given community of actors (humans and computer machines). It should also be noted that the phases of requirements specification, conceptualization, formalization, implementation, maintenance and evolution are present in most of these methods.

Of course, other consequences of our back-and-forth method concern three new concepts to integrate into our TM ontology, ontoMEDTRAD. These three new concepts are: "Translator", TMPAdvisingReferencesSMT and "ReferencesTMsource". Clearly, two of the terms in these concepts are mnemonics. In the following section, we describe the three concepts to show what they can be more semantically identified with.

- Translator

The importance of the role of the translator-interpreter is well established. When we have to conduct an interview with the TMP, the translator is indispensable. This translator is also essential when it comes to checking the content of books or the web or brochures..., whose publications are too old or undated. However, the translator may impact the knowledge collected and, in particular, a poor translator might ruin the entire process. Therefore, it is important to track the translator associated with the various pieces of knowledge collected. It would therefore be appropriate to specify the concept "Translator" in our ontology, ontoMEDTRAD. Translator will inherit from the Person class.

- TMP advising on references of TM sources : TMPAdvisingReferencesSMT

Many sources are old, dating back 20 or even 30 years. However, knowledge may have evolved and the plants available may no longer be the same, particularly as global warming may alter their geographic area range. It is therefore important to compare these sources with the opinions of current TMPs, in order to validate, correct or reject them. Some plants, notably the neem tree (Azadirachta indica), are harvested intensively. TMPAdvisingReferencesSMT is therefore the concept term chosen to canonize the TMPs that have carried a validation and confrontation opinion. This concept is subsumed by TMP, itself subsumed by Person.

- References of TM sources : ReferencesTMsource

Given their importance, the sources of knowledge and data derived from TM must be canonized. These sources include references from the web, books and scientific publications (thesis in botany, ethnobotany and bioscience) related to TM. It is precisely the contents of these sources that are concerned with the remedies and recipes used to treat a patient with a given disease. In the above, we have given some reasons for collecting TMP opinions on this TM knowledge obtained from these sources. This should be able to further reassure us about the medical virtues of these resources in human health. All these TM sources found on the web or contained in books or in documents (brochures, bioscience documents, thesis and scientific publications) and having object as TM recipes, remedies and medicinal resources are to be retained in our ontology. ReferencesTMsource is the concept term canonizing all these TM sources. It is subsumed by Thing, the universal class, as it does not yet have an explicit ontological existence class subsuming it in ontoMEDTRAD.

C. Onto MEDTRAD : Integration of Three Concepts: Translator, TMPAdvising References SMT and ReferencesTMsource

Three concepts (classes), Translator, TMPAdvisingReferencesSMT and ReferencesTMsource have been integrated into ontoMEDTRAD, specifically in its ontoCONCEPT-Term module, which is entirely terminological, whereas its ontoICONE module is both terminological and iconic. For that, we have used Protégé tool in which ontoGraf is a plugin for visualizing ontologies (owl, owl/xml, rdf/xml, turtle, …). In Fig. 4, the use of Ci symbologies (with i from 1 to 3) is only intended to highlight these three newly integrated concepts.
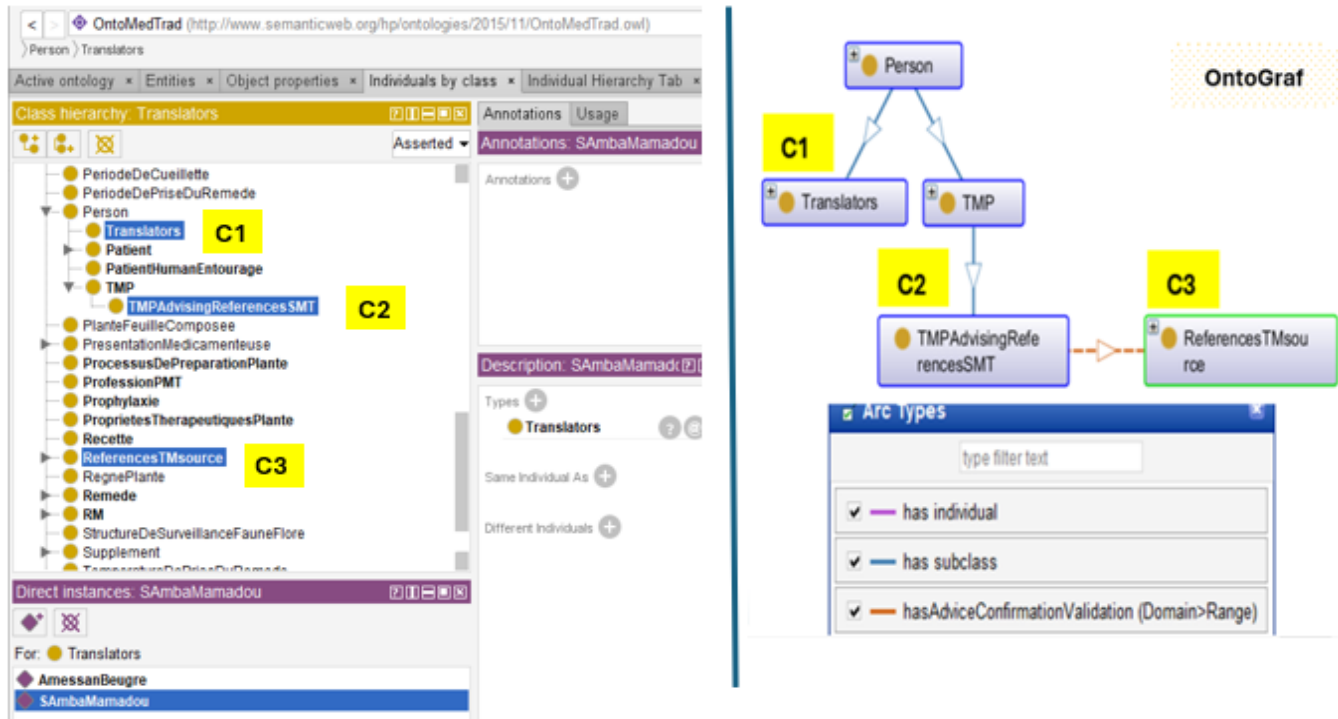

Fig. 4.   Three integrated concepts in ontoMEDTRAD : Translator (**C1**), TMPAdvisingReferencesSMT (**C2**) and ReferencesTMsource (**C3**).

V.   DISCUSSION

In this paper, we proposed an original method for knowledge elicitation in a context of multilingualism, illiteracy and secretiveness. We applied this method to the elicitation of knowledge relative to TM in West Africa.

The method used allows secrecy to be partially reduced. To do this, the knowledge, information and data gathered from the TMP during at least two successive visits are compared to establish their stability. In this way, information and knowledge that are not stable and consistent with the same questioning concerns are either questioned and rediscussed with the TMP, or rejected with the exclusion of that TMP. With the help of the translators who follow our method, multilingualism, illiteracy and secrecy are largely overcome. Our ultimate goal is to reduce the semantic gap between knowledge and information acquired through TMPs and reality. The second level of response for a sustainable solution to the three challenges is found in the ontology, ontoMEDTRAD, through its two aspects, one terminological and the other visual-iconic. At this level, the consensus inherent to ontolgy such ontoMEDTRAD, is necessary between experts PMT in the face of secrecy. Iconic language frees these PMTs from the linguistic barriers associated with proven multilingualism and illiteracy.

In our defined collection approach, the translator may speak more than two local languages in addition to the official language. At the very least, the translator understands both the official language of the country where the TMP is working and this TMP's local language. He is an important pillar of trust. However, he can also be the source of important semantic bias when translating the TMP knowledge. We note that the translator's selection is facilitated by recognized structures (e.g. Prometra, a TM NGO in Senegal and PNPMT, a public TM program structure in Côte d'Ivoire).

To avoid the TMP becoming aware of the repetitive nature of the interviews, two key elements can be taken into account the number of translators and the number of interview visits to the TMP. We recommend two translators who alternate between two visits with the same TMP. Indeed, after one interpreter's intervention, another follows for the next visit of interviews session for the same TMP. However, an additional burden of collection resources can be a drawback. Nor should the number of interpreters be inflated, to avoid semantic bias. It is therefore preferable to recruit people who are sufficiently multilingual to already achieve a certain degree of semantic uniformity in the collection. From this point of view, the duration parameter could be suitably adapted. It is also necessary to create a changing environment during the different visits for the TMP interviews and for the confrontation of TMP opinions with specific physical

or digital contents of TM already collected from books, documents, publications, thesis and websites. These contents are all aimed at the relevance of TM primary care offerings. They are therefore specific not only to diseases, recipes and remedies, but also to medicinal resources seen as the raw materials for these recipes and remedies. These resources include minerals, animals and plants, certain natural instruments such as the pestle and mortar, and other traditional means and protocol used by TMP. The order of the questions should not be static from one interview to the next, even if the targeted content stays the same. Groups of questions can be maintained so as not to distort the semantics targeted above all. It is also advisable to broaden the range of elicitation techniques. It is therefore of great interest to ensure the regularity, stability or convergence of the content of the TM knowledge and data collected or acquired despite the heterogeneity of the sources [14, 24, 25, 26, 27, 28, 29, 30], with considering the TMP as a pivot expert. The knowledge base obtained will have to undergo a continuous enrichment of consensual and stable knowledge around the expert TMPs. We have opted to leave the TMPs in their natural working states without any overwhelming influence. That's why we don't make them come to us, but we have decided to go to them through these collection visits. They have been trained to be attentive with a pedagogical attitude.

For TMPs (ITs) who are more open to the research study, we could increase the number of collection channels in the sense of back-and-forth method, which is such an important part of our strategy.

Furthermore, valuing TM also means engaging and convincing all levels of society, and populations in general to accept TM primary health care offerings without inferiority or superiority complexes, stigmatization or discrimination. Mutual acceptance between the world of TM and the one of conventional medicine (CM) [15] needs to be strengthened through their gradual integration of the former into the second [33].

It should be noted that it is not easy to define the critical threshold of the ontology's population to enter its effective exploitation phase. This work has also made it possible to obtain figures on the frequency of use of medicinal plants, and thus to determine which plants are most frequently used (frequently prescription plant). These results could also be invaluable in making the protection of these plants a priority in the current context of climate change and deforestation.

The results obtained as shown in Table V, suggest a high heterogeneity in the use of plants by TMPs : Six plants were used, each, for treating 10 or more diseases, and no plant-disease association was cited by more than 15 TMPs (out of 79). This heterogeneity may be related to the lack of oral and secretive dimensions of TM. Future works may be needed in order to determine which plant-disease associations are significant, e.g. by fixing a minimum number of citations.

This raises the question of strengthening the cultivable reproduction capacity of prescribed TM plants threatened with extinction for a variety of reasons (global warming, pests and parasites capable of attacking certain medicinal resources (plants and animals) [31]. It should also be noted that Table V is rich in significant interpretations, not all of which have been annotated.

VI. CONCLUSION

In TM of west Africa, multilingualism, illiteracy and secrecy are the basic obstacles to sharing and exchange collaboratively in this field of health. The traditional methods for gathering data and knowledge from TMP experts, mostly illiterate, are no longer appropriate. We have therefore proposed a specific and original method, "back and forth", for verbatim collecting knowledge and data. The backbone of the "back and forth" is based on the content stability of the interviews carried out during the TMP visits. It therefore involves the repetition of interviews. Increasing the semantics of data and knowledge in the technological tools under construction requires such a meticulous and careful collection method. It is a rigorous , sequenced and recursive method that makes it possible, at the end of stage 2, known as interview 2 or RDV 2, to take decision : continue with a third interview, exclude the TMP, or include the TMP. It is easy to see whether the data, knowledge and experience collected or acquired from a given TMP, become stable from this stage onwards. Enhancing the value of TM is about improving the environment of all the links in the chain around the TMP as a pivot from the detection of symptoms and diseases to the administration of primary health care on the patient. TMP is also at the heart of the collections source [14, 24, 25, 26, 27, 28, 29, 30] on this TM until we can have ontoMEDTRAD operationally.

With this method, the comparison of old reference TM sources (before 2000) with the opinions of the TMP has proved to be more than necessary in view of climate change, in order to update the data concerned (resources plant, animal, mineral, remedy, recipe, …).

At the end of the application of this back-and-forth method, we have reliable data and knowledge that can constitute a stable core that will guarantee the future exploitation and evolution of the technological tools (ontoMEDTRAD, SysMEDTRAD). In addition, there is the emergence of three new concepts to be integrated into ontoMEDTRAD. As this detailed method has highlighted their crucial role, these concepts are: "translator", TMPAdvisingReferencesSMT and ReferencesTMsource.

This work also made it possible to obtain, by means of figures and graphs, the frequency of use of medicinal plants (medicinal resources) in terms of prescription by TMP. So, it's clear which plants are the most widely used and the most virtuous. These results could be invaluable in ensuring the physical preservation of these plants as a priority, in the current context of climate change or disruption [31], deforestation or abuse of all kinds of uses of these plants. In the same vein, we need to raise awareness among the general public, including TMPs, of the importance of building and preserving botanical and wildlife gardens.

This back-and-forth method is special because it goes out of conventional and classic methods of gathering data and knowledge. It makes our strategy, of which it is a part, inductively original.

This work augurs well for the architectural reinforcement not only of ontoMEDTRAD, but also of the intelligent applications (as SysMEDTRAD) that will use it.

In perspective, all these awareness-raising activities carried out, which are costly and on our own funds, are still necessary on a larger scale. Thus, we recommend strengthening this strategy in Côte d'Ivoire and Senegal on the one hand, and then extending it to other countries in the sub-region for the final and definitive validation of our tools (ontoMEDTRAD and sysMEDTRAD) at the national and sub-regional levels in West Africa.

Compliance with ethical standards

Disclosure of conflict of interest:

No conflict of interest related to the publication of the article.

Statement of informed consent:

Informed consent was obtained from all individual participants included in the study.

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ANNEXES

INTERVIEWS AND QUESTIONNAIRE : COLLECTING DATA FROM TMP ON TM.

I-Descriptive data on TMP : (id, name, last name, age, sex, nationality, start date of the healer activity, neighborhood, city/ municipality)

II-Study levels (illiterate, primary, secondary, higher, doctoral student, postdoc, Koranic)

III-Specialities (traditional birth attendant, dietician, herbalist, naturotherapist, phthotherapist, psychotherapist, rebounder, traditional ophthalmologist, physiotherapist, acupuncturist)

IV-List of no more than 5 treated diseases by the TMP or TMP center : A : ... B : ... C : .... D : ... E : ...

V-other information on TMP

-monthly number of visited patients

-traditional health care centre Yes/no if yes specify the name of the centre and its identifier.

VI-Medicine or drug provenance : Plant, Animal, Mineral

VII-Preparation (PM) and administration (AM) modes :

PM : decoction, maceration, kneading, ... ; AM : drink, ablution, bath, steam bath, fumigation,...

VIII-Table of sources medicine per disease (A, B, C, D, E)

Disease A :

Plant source				
Plant name	Used Parts of plant	Collection period and schedule	Fresh or dry part of plant	Remark
....				

Animal source		
Animal name	Used Parts of plant	Remark
....		

Mineral source	Remark
Mineral name	
....	

Fig. 5.   Annexes.